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RANGE SAFETY TRANSMITTING SYSTEMS, 406-549 MHZ BAND.(U)
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1 OF 2
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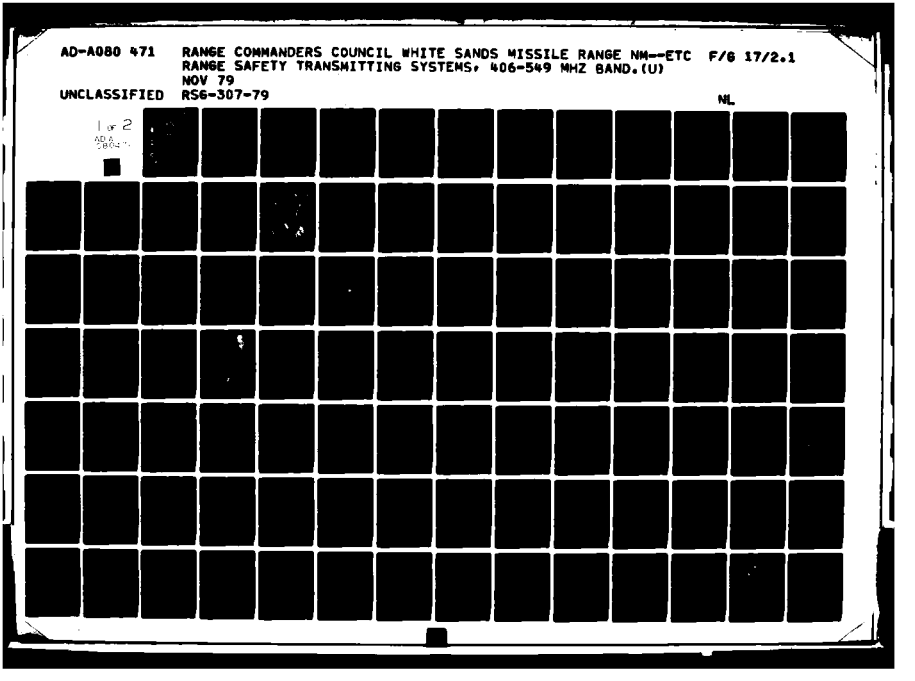

RSG

DOCUMENT 307-79

LEVEL II

RANGE SAFETY TRANSMITTING SYSTEMS 406-549 MHz BAND

RANGE SAFETY GROUP
RANGE COMMANDERS COUNCIL

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FOREWORD

The transmitting systems described herein comprise the basic command destruct transmitting systems in use at the various RCC member and associate member ranges. Sections describing each range's system and configuration and specifications for the various system components are also provided. Users of this document are encouraged to contact the range of interest to determine current configurations and obtain more detailed descriptions.

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(6) RANGE SAFETY TRANSMITTING SYSTEMS,
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TABLE OF CONTENTS

FOREWORD

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Chapter 1

INTRODUCTION

1.0 Purpose

This document serves two purposes. First, it provides information to airborne flight termination control system designers which is necessary for the selection of components and design of a system to ensure a compatible link between the ground and airborne flight termination control systems. Second, it provides the ranges, range users and other agencies with a descriptive outline of the system installed at each range.

The transmitting systems identified in this document are frequency modulated sets designed primarily to furnish safety related commands to an airborne receiving system. The unmodulated carrier and selected combinations of the 20 IRIG tones used for modulation provide: (1) airborne receiver quieting, (2) test functions to determine operability of the receiver/decoder, and (3) activation of airborne flight termination system mechanisms.

This document describes usage of the transmitters for flight termination control. In this role, certain subcarriers and the manner in which they are used must be approved by the respective range safety officer.

In all, 20 standard subcarrier channels have been defined and assigned tone numbers for ease of identification. The frequencies were selected to provide for minimal co-channel interference in accordance with the formula

$$\log_{10} F_N = 0.82275 + 0.05231N$$

where

N=tone number

F_N=frequency in kHz of tone N

The frequency is rounded off to two decimal places:

TONE NO.	FREQ (kHz)	TONE NO.	FREQ (kHz)
1	7.50	6	13.70
2	8.46	7	15.45
3	9.54	8	17.43
4	10.76	9	19.66
5	12.14	10	22.17

TONE NO.	FREQ (kHz)	TONE NO.	FREQ (kHz)
11	25.01	16	45.68
12	28.21	17	51.53
13	31.83	18	58.12
14	35.90	19	65.56
15	40.49	20	73.95

Many of the systems described contain RF equipment which is capable of operation over the entire 406-549 MHz band. However, in most areas, this frequency band is very crowded and the ranges are only authorized to radiate on certain specified frequencies. These frequencies are as follows:

RANGE	PRIMARY FREQUENCY (MHz)	SECONDARY FREQUENCY (MHz)	SPECIAL ASSIGNMENT (MHz)
AD	425		
AFWTF	520	510	425/439
KMR	445	536	
NWC	424	439	
PMTC	425		416.5
WSMC	416.5	406.5	
ESMC	416.5	406.5	
WALLOPS	412		416.5
WSMR	409		
BERMUDA	416.5		
AFFTC	483	487	

Chapter 2

ARMAMENT DIVISION (AD)
(EGLIN AFB, FLORIDA

2.0 Armament Division (AD) System

The AD command destruct transmitting system consists of two stations: A-3 located on Santa Rosa Island, and D-3 located at Cape San Blas. Both provide adequate coverage of the entire area as shown in figure 2-1. The stations may be configured to operate independently to control two unmanned systems simultaneously or may be chained together so that control can be passed from one to the other as the mission progresses.

System control is provided from a master site with the option to transfer control to alternate sites or local control. The site in control (except local control) can select and control the carrier, the modulation and the antenna on the prime and backup transmitter.

The range safety philosophy employed permits the use of the transmitter sites for control of targets. When required on target control flights, range safety flight termination commands override the target control commands by use of a "Contractor Disable" function.

Each site is equipped with a Gabriel Model AT-781/U omni antenna and a steerable Secor antenna (beamwidth of 25° to 45' at 420.9 MHz). Pen recorders provide a history of modulating tones, transmitting site and switchover time. Voice communications are also recorded.

Redundant transmitters with both automatic and manual switchover capability exist at each site. Troubleshooting is facilitated by a supervisory feature which detects the absence of a carrier tone on any channel and provides an alarm to indicate such a failure to maintenance personnel. The particular rack and tone channel in which the failure has occurred is indicated by red lights. The channel equipment, relays and subassemblies are contained in plug-in units, thereby expediting repair. A fail-safe option is provided to cause the receiving polar relay to be poled to either the mark or space position with loss of tone.

The locations of the sites are depicted in figure 2-2. Geodetics are as follows:

	LATITUDE	LONGITUDE	ELEVATION
Site A-3 (pad 12)	30°23'25.190"	86°33'26.850"	36.27 ft m.s.l.
Site D-3	29°40'31.400"	85°20'48.516"	43.055 ft m.s.l.

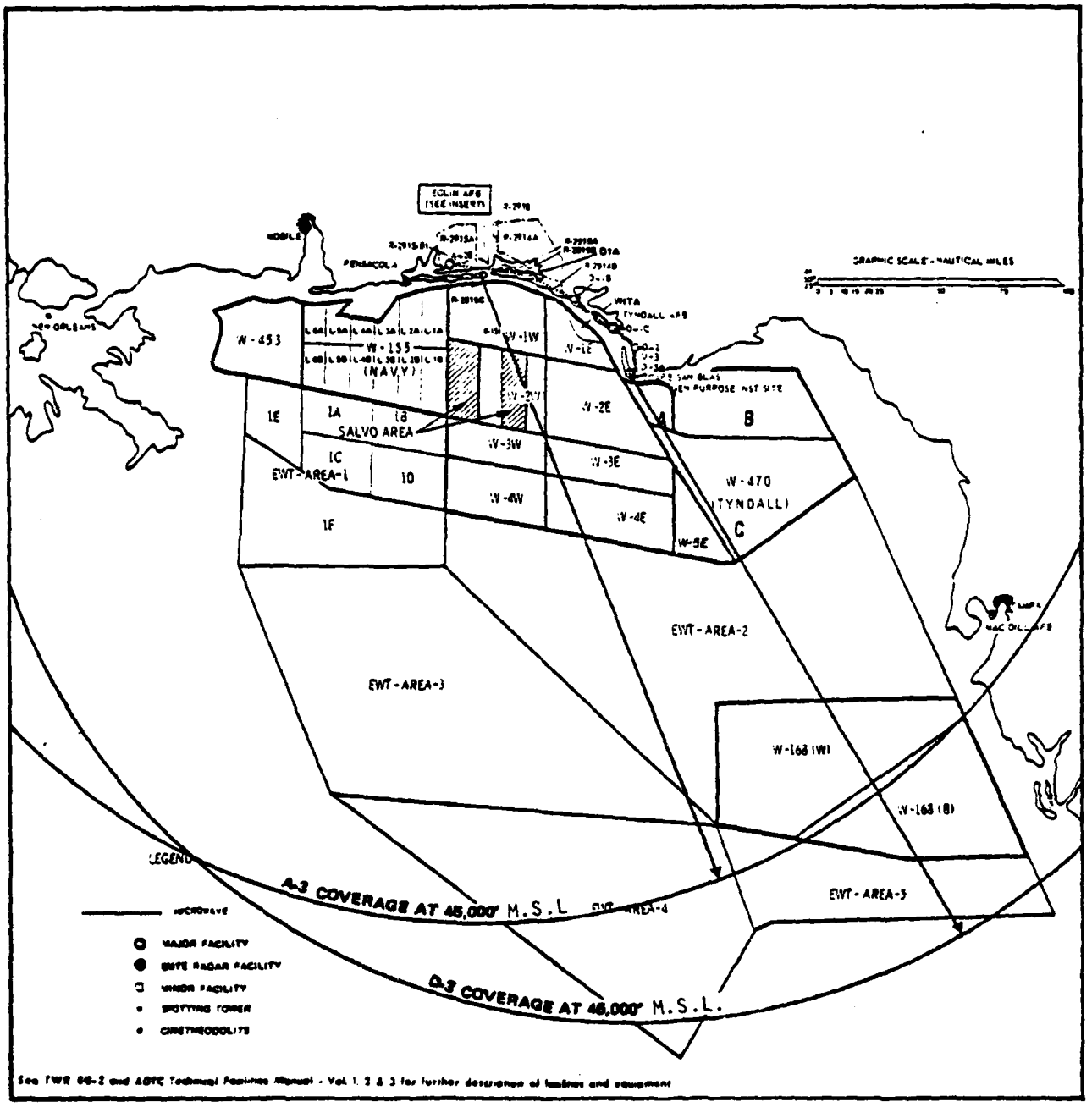


Figure 2-1 A-3 and D-3 Area Coverage at AD.

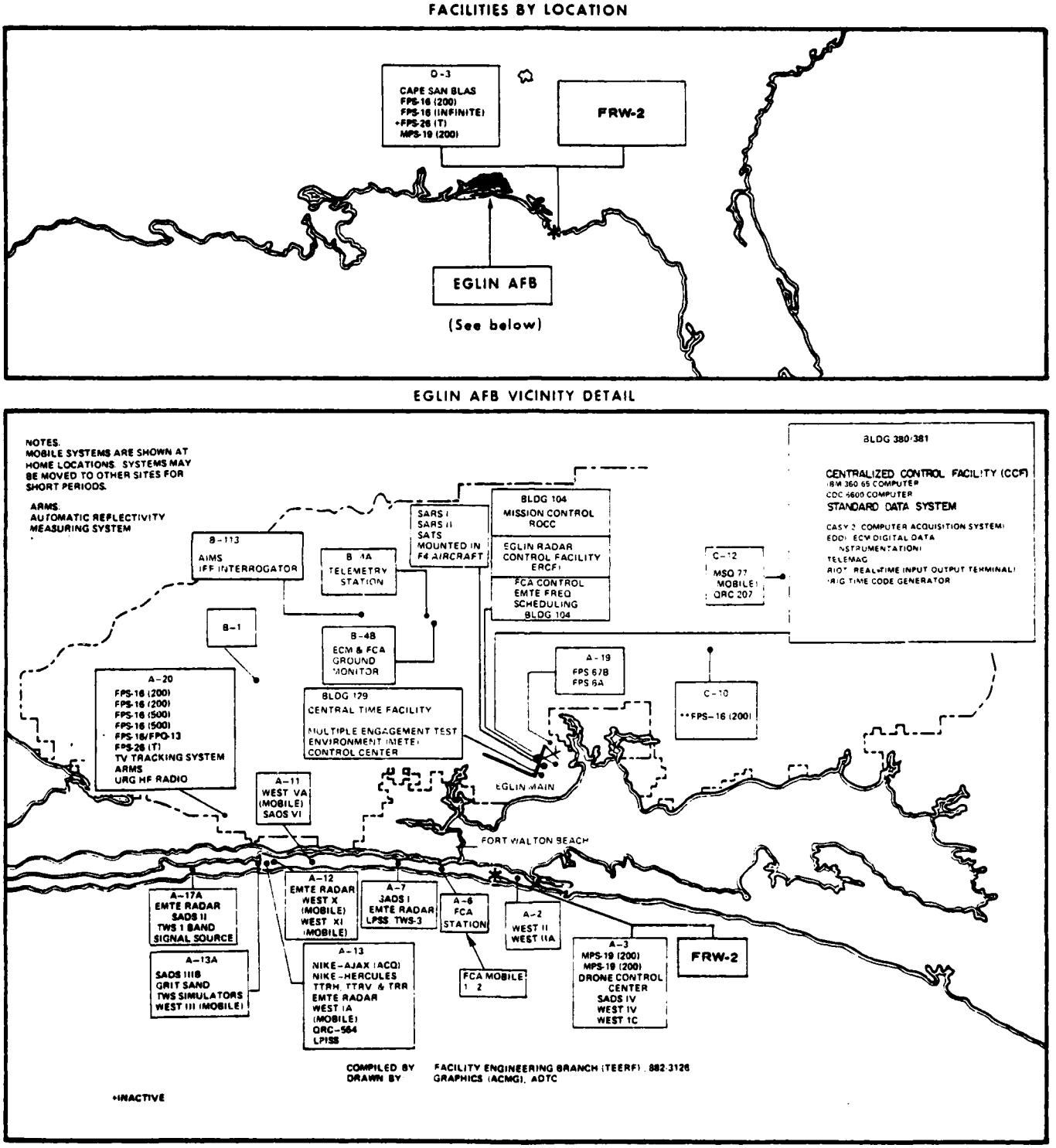


Figure 2-2 Location of A-3 and D-3 on AD.

2.1 A-3 and D-3 Site Descriptions

Both sites utilize AN/FRW-2 transmitting sets. Site A-3 has two pairs, while site D-3 has a single pair. Radiation and modulation control can be effected manually or from a remote control site. A block diagram of the system is shown in figure 2-3.

RF failure protection is provided by a station guardian. With the dual installation of radio transmitting set AN/FRW-2, one transmitter operates as a master and the other operates as a standby. When the RF output power falls below a preset value, output from the directional coupler operates the station guardian. The station guardian causes the standby transmitter to be turned on and the antenna to be switched to the standby transmitter output.

Local modulation control is exercised manually; however, there are provisions for an automatic sequence of four tones to be initiated. Modulation can also be controlled from a remote site through a frequency shift keying system. Control is achieved by manually providing a switch closure to the transmission system from one of the control sites. The transmission system uses frequency shift keying with the transmission of a one-tone frequency indicating a mark signal and the transmission of another frequency indicating a space signal. A maximum of 23 signals, using a frequency division multiplex system, can be transmitted simultaneously on one voice channel, with the two conditions of information reversible up to 40 Hz (25-ms response time). With time division multiplexing, as many as 32 signals may be transmitted over one frequency division channel. The signal is decoded at the transmitter and converted into individual command closures. These closures activate individual tones in the encoder.

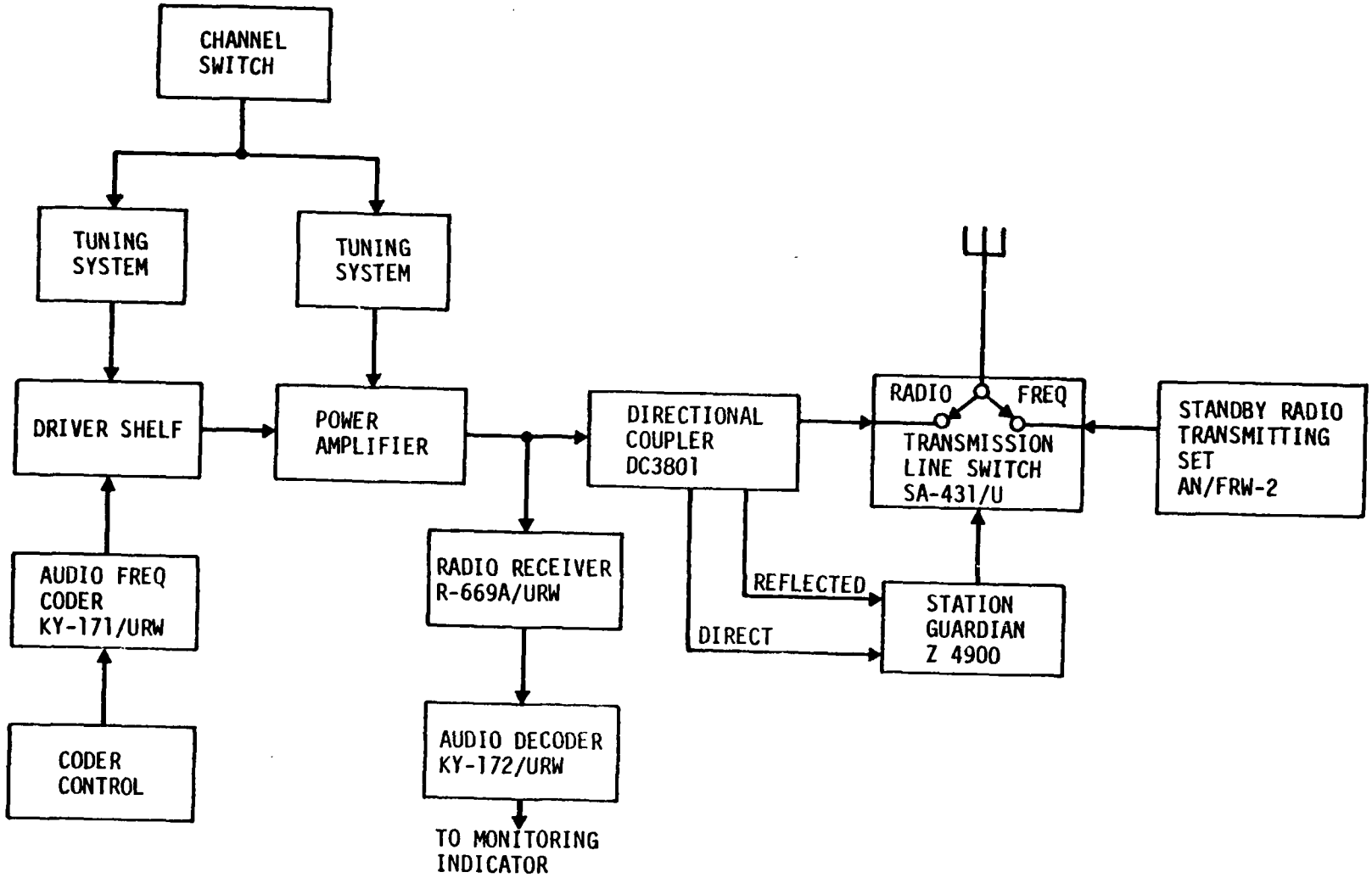


Figure 2-3 Block Diagram of Radio Transmitting Set AN/FRW-2.

2.1.1 Encoder	
2.1.1.1 Description - KY 171 (ITTL coder also available)	
2.1.1.2 Available Tones	20
2.1.1.3 Number of Simultaneous Tones	6
2.1.1.4 Tone Frequency Tolerance	±1.0%
2.1.2 RF Source	
2.1.2.1 Description - AN/FRW-2	
2.1.2.2 Frequency Range	406-549 MHz
2.1.2.3 Assigned Operating Frequency	425 MHz
2.1.2.4 Frequency Tolerance (Accuracy and Stability)	0.01%
2.1.2.5 Maximum Modulated Deviation	±300 kHz
2.1.2.6 Maximum Residual Modulation	9 kHz
2.1.2.7 Maximum Driver Output	40 W @ 409 MHz 25 W @ 549 MHz
2.1.3 RF Final	
2.1.3.1 Description - AN/FRW-2	
2.1.3.2 Power Output	500-1000 W
2.1.4 Antennas	
2.1.4.1 Fixed	
2.1.4.1.1 Description - Gabriel Model AT-781/U	
2.1.4.1.2 Polarization	Left circular
2.1.4.1.3 Gain	5 dB over isotropic
2.1.4.1.4 Beamwidth	Omni
2.1.4.1.5 Power Rating	1 kW
2.1.4.1.6 Type Feed	Power divider

2.1.4.1.7 Impedance	50Ω
2.1.4.1.8 Frequency Range	406-549 MHz
2.1.4.1.9 Voltage Standing Wave Ratio (VSWR)	1.4:1 @ 406 MHz 1.8:1 @ 549 MHz
2.1.4.2 Steerable	
2.1.4.2.1 Description - Secor	
2.1.4.2.2 Polarization	Left circular
2.1.4.2.3 Gain	10 dB min @ 420.9 MHz
2.1.4.2.4 Beamwidth	25°-45° @ 420.9 MHz
2.1.4.2.5 Sidelobes	<11 dB
2.1.4.2.6 Power Rating	2 kW
2.1.4.2.7 Impedance	50Ω
2.1.4.2.8 Frequency Range	412.9-428.9 MHz
2.1.4.2.9 VSWR	1.2:1 max @ 420.9 MHz
2.1.4.2.10 Type Mount, Mfr, Model	3511M Mount Type F-198E TM
2.1.4.2.11 Maximum Slew Rates, Azimuth and Elevation	15°/s AZ 10°/s EL
2.1.4.2.12 Positioning Lag	±5% @ max speed
2.1.4.2.13 Pointing Accuracy	±3° (est)
2.1.5 Monitor Receiver	
2.1.5.1 Description - R-729/FRW-3 and R-669/URW	
2.1.5.2 Frequency Range	406-549 MHz
2.1.5.3 Tuning Method	Manual
2.1.5.4 Antenna Type and Characteristics	Directional coupler

2.1.6 Decoder

2.1.6.1 Description - KY-172

2.1.6.2 Number of Channels 20

2.1.7 Recording System

2.1.7.1 Description - Pen recorders are utilized to record the following data:

Tones ordered locally	-	20 max
Tones ordered remotely	-	Any six at one time
Tones transmitted	-	Individual tones
IRIG timing	-	
Switchover time	-	0.5 s

In addition, magnetic recording of voice communications and frequency monitoring of the active transmitter are provided.

Chapter 3

ATLANTIC FLEET WEAPONS TRAINING FACILITY (AFWTF) ROOSEVELT ROADS, PUERTO RICO

3.0 Atlantic Fleet Weapons Training Facility (AFWTF) System

The AFWTF command system is composed of five transmitter sites as shown in figure 3-1. The system is configured to cover test areas for control of both surface and airborne targets. Four of the systems are identical and are built around AN/SWR-4D systems (URW-15), the fifth, located at Cerro Matias, Vieques, utilizes AN/URW-14. Area coverage of the various stations is depicted in figure 3-2.

A Milgo Remote Data and Drone Control System (RDDCS) permits remote control of both the carrier and modulation of the high power systems from the RDDCS drone control room in the Range Operations Center (ROC) at Puerto Rico. The fifth system is manually controlled for operations; all sites have local control for maintenance. Each station is configured with one omni antenna and one 12-dB steerable antenna connected to a transmitter so that either configuration may be selected by the controller. The controller also manually selects the active station. Steerable antennas are manually pointed through a motor driven rotator. An automatic switchover activates the redundant transmitter in a station in the event that the primary transmitter fails. System reliability is 98 percent.

A site summary is contained in table 3-1.

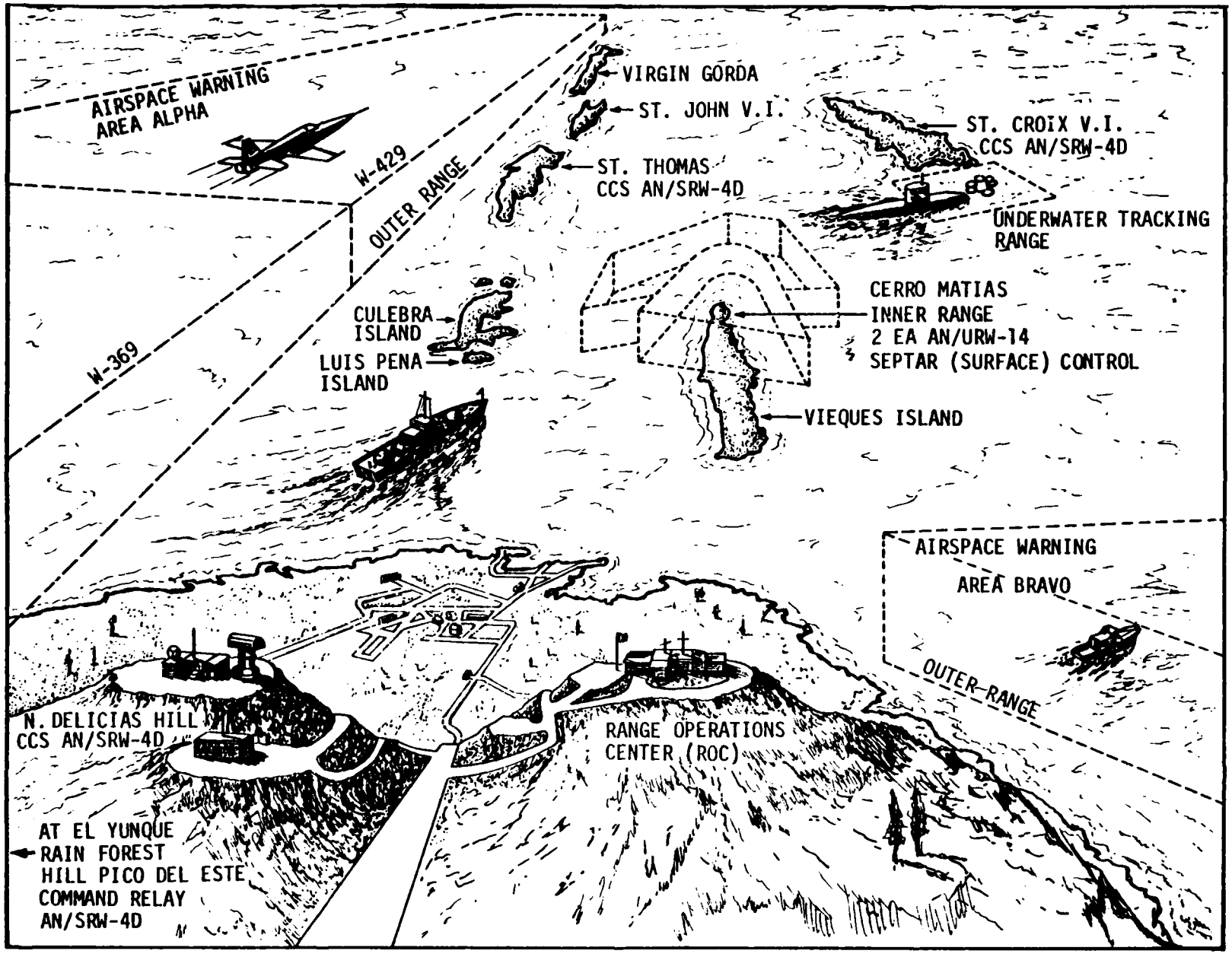


Figure 3-1 Flight Termination System at AFWTF.

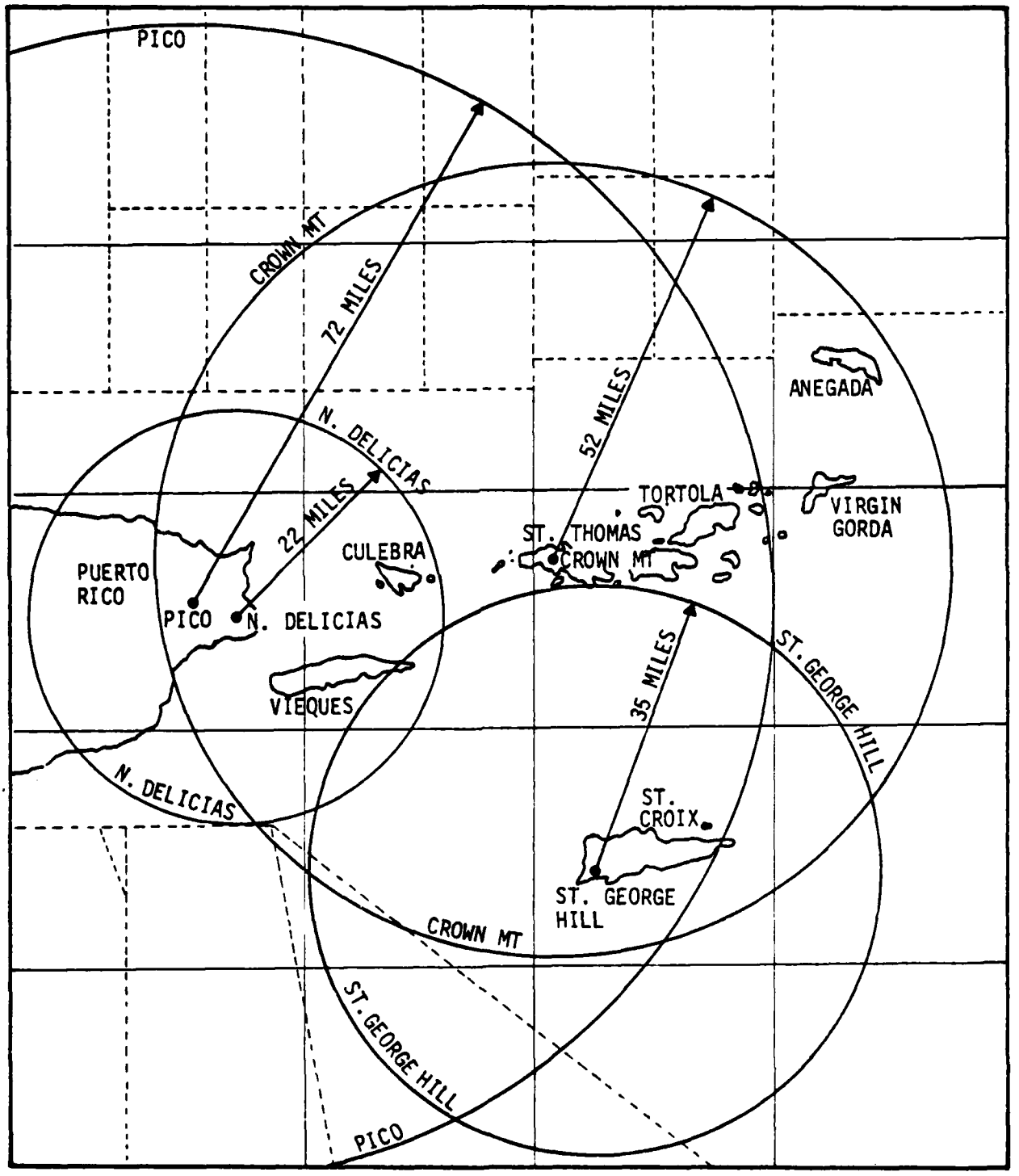


Figure 3-2 Flight Termiantion System Area Coverage at AFWTF.

TABLE 3-1

AFWTF SITE SUMMARY

SITE	LATITUDE	LONGITUDE	ELEVATION	POWER OUTPUT	STEERABLE	OMNI
North Delicias (P.R.)	18°13'46.55"	65°39'5.23"	329 ft	1 kW	1-12 dB	2
St. Thomas (Crown Mt)	18°21'31.47"	64°58'19.24"	1541.99 ft	1 kW	2-12 dB	-
St. Croix (St. George Hill)	17°43'14.07"	64°51'28.34"	864 ft	1 kW	1-12 dB	2
Pico Del Este (P.R.)	18°16'14.32"	65°45'32.12"	3418.23 ft	1 kW	1-12 dB	2
Cerro Matias, Vieques (P.R.)	18°8'0.65"	65°19'3.67"	454.07 ft	100 kW	-	2

3.1 Outer Range Sites

These sites are remotely controlled from the ROC to provide guidance for drones involved in weapons tests. Control of the Pico Del Este site is achieved through a Command A Relay System through an AN/DRW-29 working with the AN/SWR-4D system. The others are controlled through the RDDCS.

3.1.1 Encoder

3.1.1.1	Description - Babcock, integral with RF source	
3.1.1.2	Available Tones	20
3.1.1.3	Number of Simultaneous Tones	6
3.1.1.4	Tone Frequency Tolerance	±1%
3.1.1.5	Distortion	10%
3.1.1.6	Composite Signal Amplitude Stability	1 V
3.1.1.7	Tone Off Level	0.2 V
3.1.1.8	Turn On Delay Time (to 90-Percent Level)	10 ms
3.1.1.9	Turn On Jitter at Maximum Repetition Rate	None
3.1.1.10	Command Function Tone Balance	300 kHz

3.1.2 RF Source

3.1.2.1	Description - Babcock AN/URW-14	
3.1.2.2	Frequency Range	406-549.5 MHz
3.1.2.3	Assigned Operating Frequency	520 MHz
3.1.2.4	Frequency Tolerance (Accuracy and Stability)	±0.005% accuracy
3.1.2.5	Maximum Modulated Deviation	300 kHz
3.1.2.6	Maximum Total Distortion (at Maximum Deviation)	10%
3.1.2.7	Maximum Driver Output	100 W

3.1.3 RF Final	
3.1.3.1 Description - AM263/UR (AN/URW-15)	
3.1.3.2 Power Output	1 kW
3.1.3.3 Harmonic and Spurious Outputs	60 Hz @ -80 dBm
3.1.3.4 Bandwidth	143.5 MHz
3.1.3.5 RF Leakage in Standby Mode	None
3.1.4 Antennas	
3.1.4.1 Fixed	
3.1.4.1.1 Description - Gabriel Model AT-781/UC	
3.1.4.1.2 Polarization	Left circular
3.1.4.1.3 Gain	5 dB
3.1.4.1.4 Beamwidth	Omni
3.1.4.1.5 Power Rating	1 kW
3.1.4.1.6 Type Feed	Power divider
3.1.4.1.7 Impedance	51Ω
3.1.4.1.8 Frequency Range	406-549 MHz
3.1.4.1.9 Voltage Standing Wave Ratio (VSWR)	>1.4:1,<1.8:1
3.1.4.2 Steerable	
3.1.4.2.1 Description - 4 Stacked Motorola 3606E-Z	
3.1.4.2.2 Polarization	Vertical
3.1.4.2.3 Gain	12 dB
3.1.4.2.4 Beamwidth	120°
3.1.4.2.5 Power Rating	2 kW
3.1.4.2.6 Type Feed	N connector power divider

3.1.4.2.7 Impedance	51Ω
3.1.4.2.8 Frequency Range	480-560 MHz
3.1.4.2.9 VSWR	1.2:1
3.1.4.2.10 Type Mount, Mfr, Model	Cornell-Dubilier Rotor, Model M
3.1.4.2.11 Maximum Slew Rates, Azimuth and Elevation	1 rpm, AZ only
3.1.4.2.12 Pointing Accuracy	±1°
3.1.5 Monitor Receiver	
3.1.5.1 Description - Babcock AN/URW-16	
3.1.5.2 Frequency Range	406-549.5 MHz
3.1.5.3 Tuning Method	Crystal
3.1.5.4 Modulated Band Pass (3 dB)	500 kHz
3.1.5.5 Antenna Type and Characteristics	Omni
3.1.5.6 RF Sensitivity	0.5μV
3.1.5.7 Audio Output Level	0.8-1.5 V rms
3.1.5.8 Audio Output Bandwidth	300 kHz
3.1.6 Decoder	
3.1.6.1 Description - Babcock AN/PRW-29	
3.1.6.2 Number of Channels	20
3.1.6.3 Receiver Coupled Threshold Sensitivity	10μV
3.1.6.4 Channel Bandwidth	120 kHz
3.1.6.5 Deviation/Input Range	120-300 kHz
3.1.6.6 Signal/Noise Margin	3 dB
3.1.7 Recording System	
3.1.7.1 Description - No recording available.	

3.2 Cerro Matias, Vieques Site

This site is used for control of surface targets at the Inner Range. Both modulation and radiation are locally controlled. The low power is appropriate to the size of the range. Output power is monitored by the station operator to preclude the need for an automatic switchover.

3.2.1 Encoder

3.2.1.1	Description - Babcock, integral with RF source	
3.2.1.2	Available Tones	20
3.2.1.3	Number of Simultaneous Tones	6
3.2.1.4	Tone Frequency Tolerance	±1%
3.2.1.5	Distortion	10%
3.2.1.6	Composite Signal Amplitude Stability	1 V
3.2.1.7	Tone Off Level	0.2 V
3.2.1.8	Turn On Delay Time (to 90-Percent Level)	10 ms
3.2.1.9	Turn On Jitter at Maximum Repetition Rate	None
3.2.1.10	Command Function Tone Balance	300 kHz

3.2.2 RF Source

3.2.2.1	Description - AN/UJRW-14	
3.2.2.2	Frequency Range	406-549.5 MHz
3.2.2.3	Assigned Operating Frequency	520 MHz
3.2.2.4	Frequency Tolerance (Accuracy and Stability)	±0.005% accuracy
3.2.2.5	Maximum Modulated Deviation	300 kHz
3.2.2.6	Maximum Total Distortion (at Maximum Deviation)	10%
3.2.2.7	Maximum Driver Output	100 W

3.2.3 RF Final	
3.2.3.1 Description - AN/URW-14	
3.2.3.2 Power Output	100 W
3.2.3.3 Harmonic and Spurious Outputs	60 Hz @ -80 dBm
3.2.3.4 Bandwidth	143.5 MHz
3.2.3.5 RF Leakage in Standby Mode	None
3.2.4 Antennas	
3.2.4.1 Fixed	
3.2.4.1.1 Description - Gabriel Model AT-781/UC	
3.2.4.1.2 Polarization	Left circular
3.2.4.1.3 Gain	5 dB
3.2.4.1.4 Beamwidth	Omni
3.2.4.1.5 Power Rating	1 kW
3.2.4.1.6 Type Feed	Power divider
3.2.4.1.7 Impedance	51Ω
3.2.4.1.8 Frequency Range	406-549 MHz
3.2.4.1.9 VSWR	>1.4:1,<1.8:1
3.2.4.2 Steerable	
3.2.4.2.1 Description - None available.	
3.2.5 Monitor Receiver	
3.2.5.1 Description - AN/URW-16	
3.2.5.2 Frequency Range	406-549.5 MHz
3.2.5.3 Tuning Method	Crystal
3.2.5.4 Modulated Band Pass (3 dB)	500 kHz

3.2.5.5 Antenna Type and Characteristics	Omni
3.2.5.6 RF Sensitivity	0.5μV
3.2.5.7 Audio Output Level	0.85-1.5 V rms
3.2.5.8 Audio Output Bandwidth	300 kHz
3.2.6 Decoder	
3.2.6.1 Description - AN/PRW-29	
3.2.6.2 Number of Channels	20
3.2.6.3 Receiver Coupled Threshold Sensitivity	10μV
3.2.6.4 Channel Bandwidth	120 kHz
3.2.6.5 Deviation/Input Range	120-300 kHz
3.2.6.6 Signal/Noise Margin	3 dB
3.2.7 Recording System	
3.2.7.1 Description - No recording available.	

Chapter 4

KWAJALEIN MISSILE RANGE (KMR)
KWAJALEIN, MARSHALL ISLANDS

4.0 Kwajalein Missile Range (KMR) System

The KMR system consists of two sites; one at Roi-Namur and one at Kwajalein as shown in figure 4-1. The Roi-Namur site utilizes AN/FRW-2 equipment mounted in a van while the Kwajalein site consists of newly designed equipment which provides a 10-kW source.

Each site is interfaced to a CDC 7600 computer in the Central Data Processing Center (CDPC) on Kwajalein to control antenna pointing and modulation control for command destruct, missile guidance and other control purposes. Both sites have redundant transmitters with automatic switchover capability. Manual control can be achieved locally and through interaction with the CDPC.

The Kwajalein system is an integral part of the Kwajalein Range Safety System (KRSS). It is designed for operator control of radiation and antenna pointing. Commands for modulation can be derived automatically from software or by manual selection either through a hardware sequence with adjustable duty cycle or through software formatted orders. Both digital and hard-copy recording is provided to allow full coverage of events.

WGS-72 geodetics are as follows:

	LATITUDE	LONGITUDE	ELEVATION (meters)	
Roi-Namur	9°21'6.9150"	167°28'4.5087"	6.032 ft m.s.l.	37.132 geodetic
Kwajalein	8°43'18.3957"	167°43'26.9584"	8.187 ft m.s.l.	39.626 geodetic

4.1 Kwajalein Site Description

The Command Control Transmitter (CCT) subsystem hardware and software are dedicated elements of the KRSS and are located at the Range Safety Center (RSC) on Kwajalein Island. The CCT provides the means to transmit commands to the airborne test vehicle with an effective radiated power of up to 2 MW covering the area shown in figure 4-2. The CCT subsystem consists of two identical high-power RF transmitters with sufficient output power to capture test vehicle receivers at the KMR horizon. Depending on user requirements, the CCT subsystem may also be tuned to any frequency within the UHF destruct band. In addition, tone modulation selection is possible using software techniques which allow the support of in-flight guidance or other command and control functions.

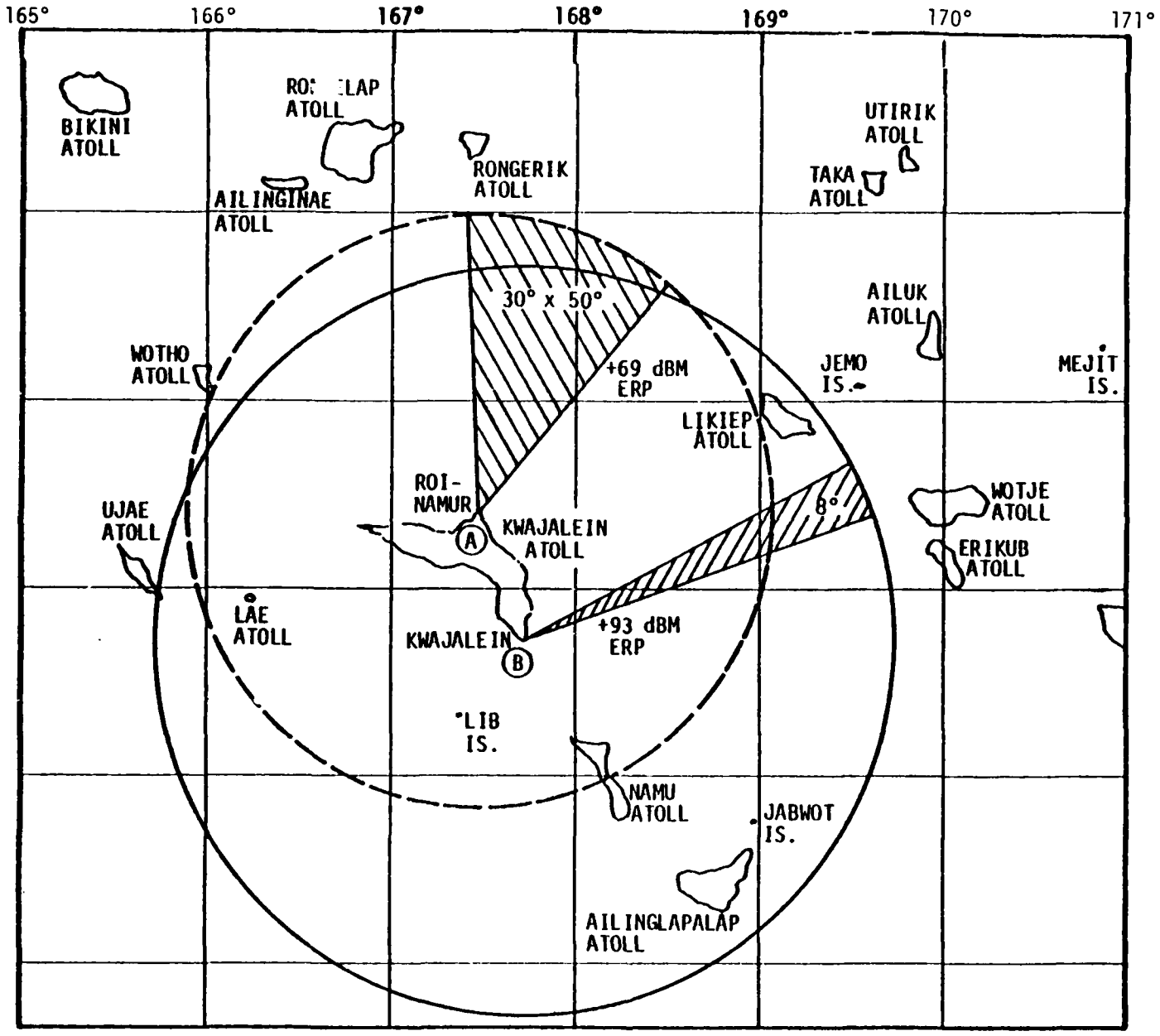


Figure 4-1 Command Control Transmitters at KMR.

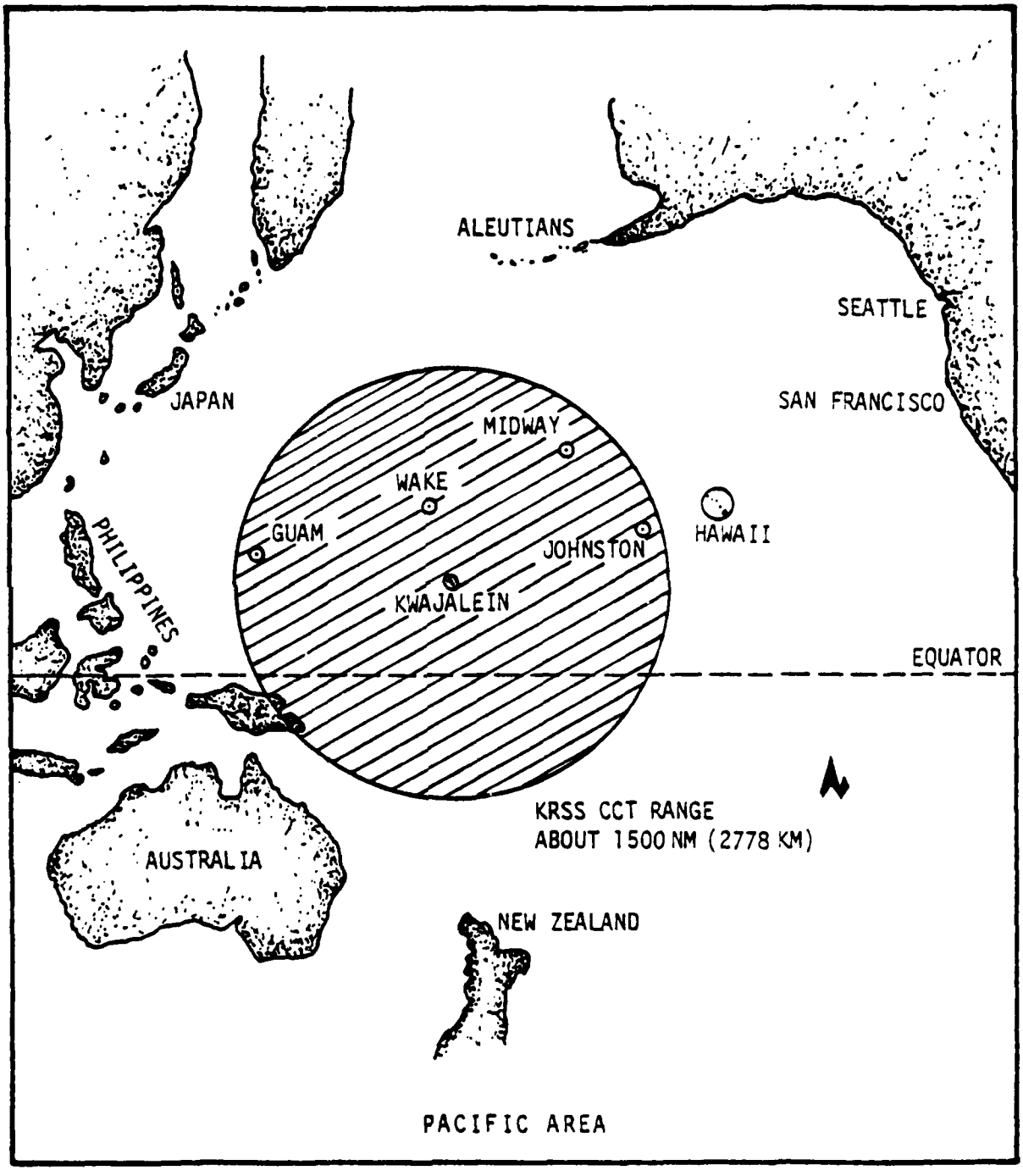


Figure 4-2 KRSS CCT Coverage Capability at KMR.

The primary facilities for the KRSS include the CDPC and the RSC. The RSC houses the Flight Safety Display Command (FSDC) and the CCT subsystems. The RSC is the central location from which all KRSS functions may be monitored and controlled by the Flight Safety Officer. The CDPC houses the main KMR computer and is the central distribution point for passing data to and from range instrumentation.

The KRSS is designed to maximize system reliability. Error checking and redundant features are incorporated wherever practical to reach a reliability design goal of 0.991. Polynomial error checking is used on all data links to ensure successful transmission. The CCT subsystem is redundant and contains a hierarchy of failure sensing circuitry. Should a failure be detected, the hardware will automatically switch to the redundant path. In addition, the reliability of the overall system is significantly increased using stringent hardware/software configuration control techniques.

The CCT subsystem consists of two digital subsystems, two radio frequency subsystems, two linear amplifiers, two transmit antennas, two monitor subsystems and an operator's console. A block diagram is shown in figure 4-3.

Each digital subsystem is comprised of two modem communication units, an SEL 810B minicomputer, and a real-time Digital Input/Output Control Unit (DIOCU). The primary modem receives azimuth/elevation pointing angles and command orders from the CDPC to drive the command antennas. The serial data is converted to parallel in 12-bit bytes for transfer to the SEL 810B minicomputer. The SEL 810B minicomputer performs data validity testing and the information is formulated for transfer to the real-time DIOCU. Should primary data to the CCT subsystem be lost from the CDPC, it is possible for the SEL 810B minicomputer to process alternate pointing data directly from one AN/MPS-36 radar using data transmitted on the backup modem link.

The real-time DIOCU performs the primary interface function between most elements of the CCT subsystem. While functioning as a standard computer peripheral, it provides direct communication between the external input/output devices and the SEL 810B minicomputer. The DIOCU provides the digital-to-analog conversion to steer the antennas and the contact outputs to key the tone encoders. The DIOCU also allows the transmission and reception of 16 discrete status bits between the two computers. These status bits may then be interrogated by the software so that each computer knows the status of the other during real-time operation.

The RF subsystems provide the means to encode and modulate commands ordered within the KRSS. Included within each RF subsystem is a tone encoder, an RF generator and a low-power amplifier. The low-power amplifiers receive the carrier signals from the RF generators. The low-power

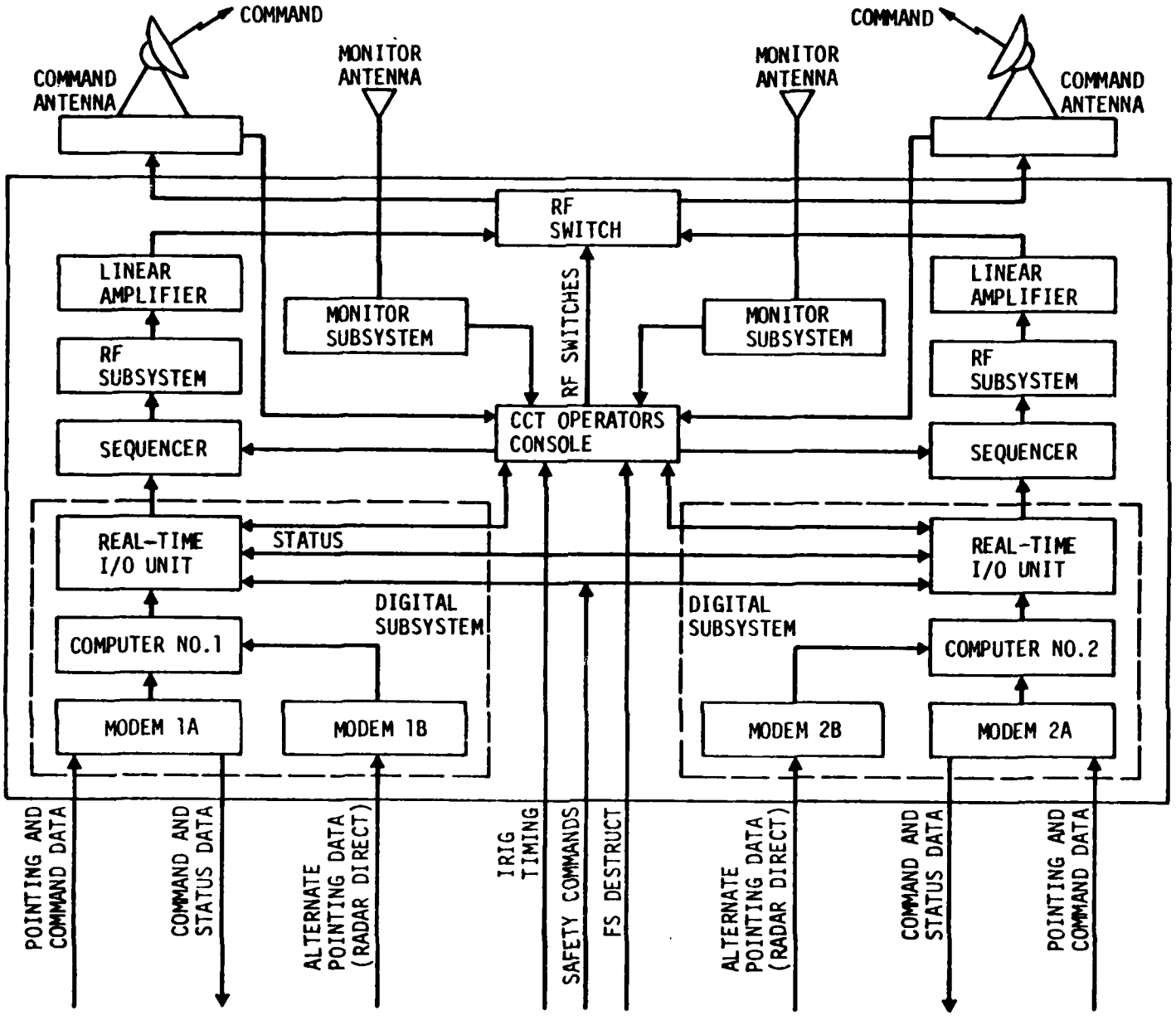


Figure 4-3 Block Diagram of the KMR Command Control Transmitter Subsystem.

amplifiers which receive carrier signals from the RF generators are linear, wideband and solid state. They are capable of delivering 5 W of RF power to the high-power amplifiers.

The high-power amplifiers provide RF amplification with an output of 10 kW. Modulation is tone frequency with up to ±300 kHz deviation. A redundant system is employed which maintains one amplifier system in standby while one is on-line. In the event of failure, an automatic switchover occurs to place the standby unit on-line within 55 ms. There are two liquid-cooled heat exchangers used for cooling the klystron amplifier tubes; each heat exchanger cools one kylstron amplifier tube.

An RF switch network accepts the signals from the high-power linear amplifiers. It also accepts switching signals from the operator's console or the real-time DIOCU, and provides inputs to either the antennas or the dummy loads.

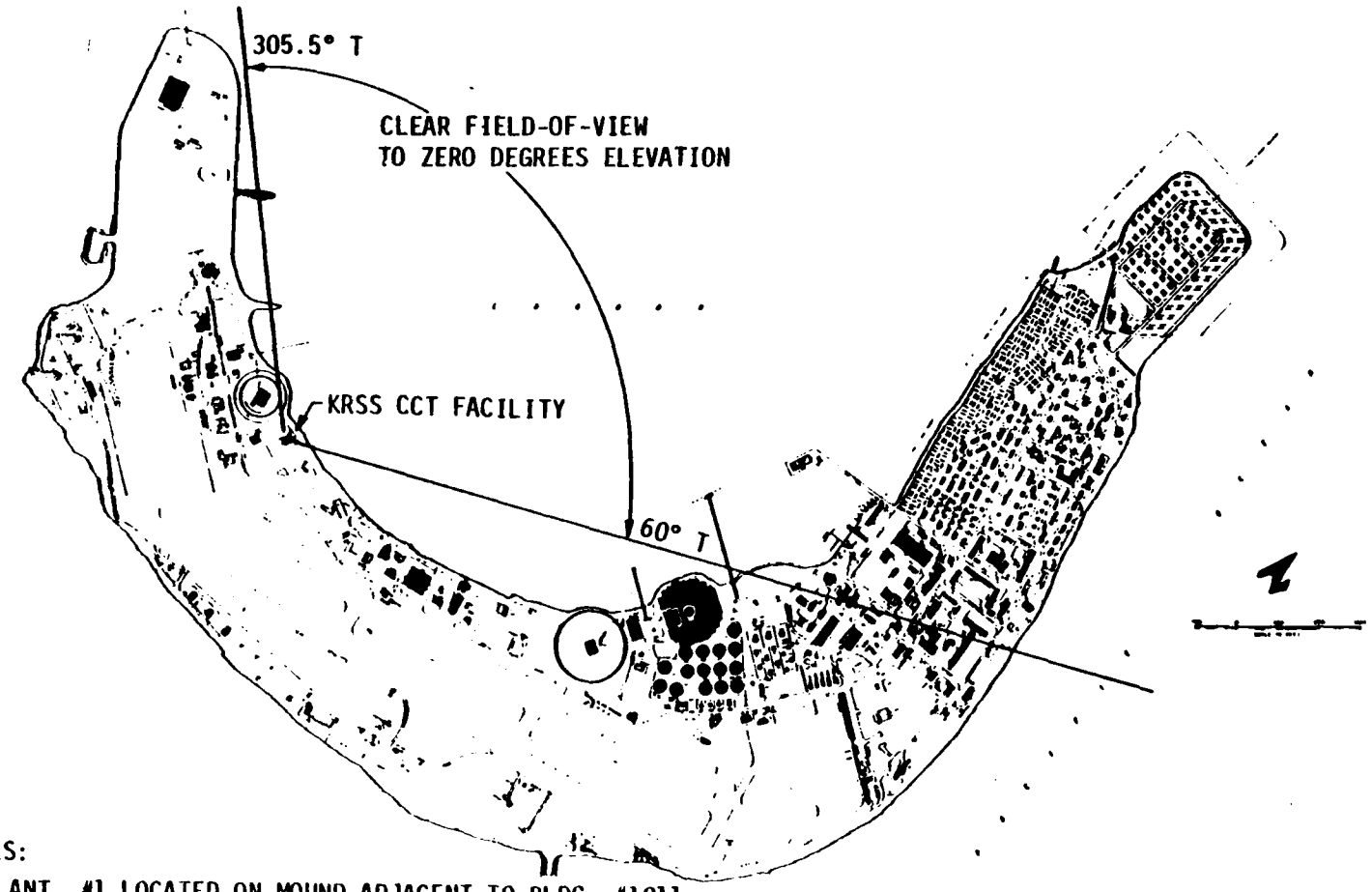
Each of the two 20-foot redundant parabolic antennas uses a two-axis elevation-over-azimuth pedestal on a riser base. Radiation is left-hand circularly polarized (LHCP) with a pointing accuracy of 0.1° and a beamwidth greater than 7° at half power. Operating freedom is shown in figure 4-4.

The monitor subsystem provides the means to monitor the CCT subsystem radiated carrier modulation. The monitor subsystem includes monitor antennas, receivers, decoders and stripchart recorders.

The monitor antennas receive a portion of the radiated signals from the transmitting antennas. The receivers demodulate the signals and output the demodulated signals to the decoders. The decoders output a discrete signal for each IRIG tone present in the modulation. The tone indicator signals are output to the encoder/decoder display panel on the operator's console, the real-time DIOCU and the stripchart recorders. The stripchart recorders provide hard-copy records of system functions, events and switch positions.

The operator's console provides centralized control of the CCT subsystem by furnishing capabilities to turn carriers on, select the prime system, disable automatic switchover and remote controls, manually position the antennas, and transmit individual tones or commands.

Synchronized time code generators provide range timing for the CCT subsystem. The generators receive IRIG B signals from the master timing center, phase-lock their local oscillators to the input signals, and output pulse rates and IRIG time codes to the components of the CCT subsystem.



NOTES:

1. ANT. #1 LOCATED ON MOUND ADJACENT TO BLDG. #1011
2. ANT. #2 LOCATED ON TOP OF BLDG. #1011

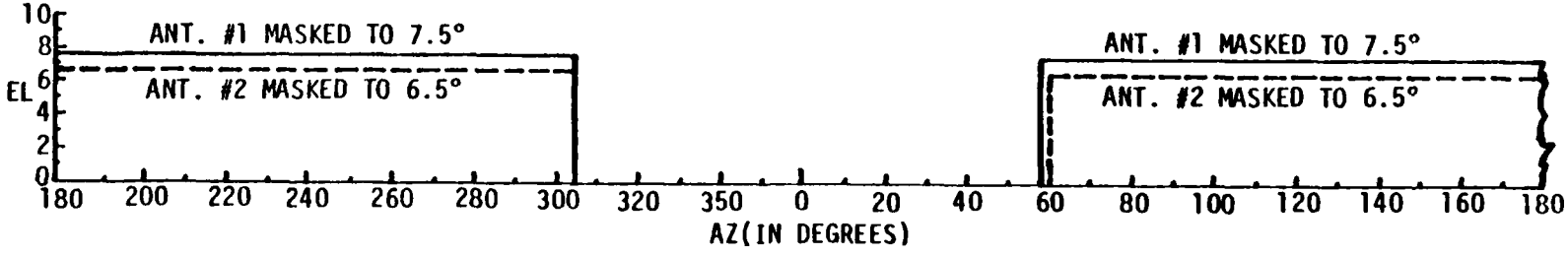


Figure 4-4 KRSS CCT Location on KHR.

4.1.1 Encoder

4.1.1.1	Description - Part of RF subsystem 8695-8696 manufactured by Metric Systems, Fort Walton Beach, Fla., Kentron Spec HV-6020-115-76.	
4.1.1.2	Available Tones	20
4.1.1.3	Number of Simultaneous Tones	10
4.1.1.4	Tone Frequency Tolerance	0.1%
4.1.1.5	Distortion	1.0%
4.1.1.6	Composite Signal Amplitude Stability	±5%
4.1.1.7	Tone Off Level	0.05±0.05 V
4.1.1.8	Order Repetition Rates	0-100 pps
4.1.1.9	Turn On Delay Time (to 90-Percent Level)	0.5 ms max
4.1.1.10	Turn On Jitter at Maximum Repetition Rate	±50μs
4.1.1.11	Turn Off Delay Time	0.5 ms max
4.1.1.12	Composite Transient Output (Switching)	0.1 V peak - 50μs
4.1.1.13	Command Function Tone Balance	±5%

4.1.2 RF Source

4.1.2.1	Description - HP 8660C generator with 86602 (extended) RF section and 86632B modulation section	
4.1.2.2	Frequency Range	406-550 MHz
4.1.2.3	Assigned Operating Frequency	445/536 MHz
4.1.2.4	Frequency Tolerance (Accuracy and Stability)	±0.00005%
4.1.2.5	Deviation Linearity	±1% @ 300 kHz
4.1.2.6	Maximum Modulated Deviation	±300 kHz
4.1.2.7	Maximum Residual Modulation	±2 kHz

4.1.2.8 Maximum Total Distortion (at Maximum Deviation)	2%
4.1.2.9 Maximum Driver Output	10 W
4.1.3 RF Final	
4.1.3.1 Description - MCL Model 10533, Kentron Spec HV-6020-165-75	
4.1.3.2 Power Output	10 kW
4.1.3.3 Harmonic and Spurious Outputs	-60 dB
4.1.3.4 Bandwidth	3 MHz
4.1.3.5 RF Leakage in Standby Mode	-60 dB
4.1.4 Antennas	
4.1.4.1 Fixed	
4.1.4.1.1 Description - None available.	
4.1.4.2 Steerable	
4.1.4.2.1 Description - Datron Systems, Inc., Kentron Spec HV-6020-015-76	
4.1.4.2.2 Polarization	Left circular
4.1.4.2.3 Gain	25 dB
4.1.4.2.4 Beamwidth	7°
4.1.4.2.5 Sidelobes	-15.6 dB
4.1.4.2.6 Power Rating	15 kW
4.1.4.2.7 Type Feed	Coaxial
4.1.4.2.8 Impedance	50Ω
4.1.4.2.9 Frequency Range	406-550 MHz
4.1.4.2.10 Voltage Standing Wave Ratio (VSWR)	1.25:1
4.1.4.2.11 Type Mount, Mfr, Model	EL-AZ Datron 8z53

4.1.4.2.12 Maximum Slew Rates, Azimuth and Elevation	15°/s
4.1.4.2.13 Positioning Lag	5° max
4.1.4.2.14 Pointing Accuracy	1°
4.1.5 Monitor Receiver	
4.1.5.1 Description - Microdyne AR-1200	
4.1.5.2 Frequency Range	406-550 MHz
4.1.5.3 Tuning Method	Continuous
4.1.5.4 Modulated Band Pass (3 dB)	1.5 MHz
4.1.5.5 Antenna Type and Characteristics	Dipole stub
4.1.5.6 RF Sensitivity	-98 dBm/tone
4.1.5.7 Audio Output Level	2 V rms/tone
4.1.5.8 Audio Output Bandwidth	100 kHz
4.1.6 Decoder	
4.1.6.1 Description - Metric, Kentron Spec HV-6020-115-76	
4.1.6.2 Number of Channels	20
4.1.6.3 Receiver Coupled Threshold Sensitivity	0.25 V rms/tone
4.1.6.4 Channel Bandwidth	±1%/tone
4.1.6.5 Deviation/Input Range	±300 kHz
4.1.6.6 Adjacent Channel Rejection	40 dB
4.1.6.7 Signal/Noise Margin	12 dB
4.1.6.8 Command Output Response Time	5 ms
4.1.6.9 Response Jitter	±0.4 ms

4.1.7 Recording System

4.1.7.1 Description - Magnetic tape and chart

4.1.7.2 Functions Recorded:

Tones ordered locally
Tones ordered remotely
Tones transmitted
Antenna and transmitter radiating
Antenna position
Transmitter fault event
Switchover time
Voice communications

4.2 Roi-Namur Site

The command system at Roi-Namur (as shown in figure 4-5) consists of redundant FRW-2 transmitters, modems and an SEL 810A computer with input/output (I/O) interface unit, antenna control and positioning unit, teletype, recorder, and remote and local control positions. The system may be used for any command function which requires an RF signal from 406 to 550 MHz and is tunable in 1.0-MHz intervals.

In the normal operating mode both transmitter filament circuits are on simultaneously; one transmitter supplies power to the antenna and one is switched into dummy load. Either transmitter may be designated to be prime with the other on standby. Modulation can be commanded locally or remotely from the CDPC. Up to five tones may be ordered at a time. Lock-out switches are provided on the master console which can be set to prevent local operation when remote modulation is desired.

A fully steerable tri-helix antenna with 14-dB gain is used to provide mission support. A 14.5-dB gain fixed antenna is available as a backup. Location and coverage is shown in figure 4-6.

All command information, range time and transmitter power output are recorded on magnetic tape. Electrical interconnections are 208 V, 30 and 60 Hz. The electronic control interface is 28 V d.c.

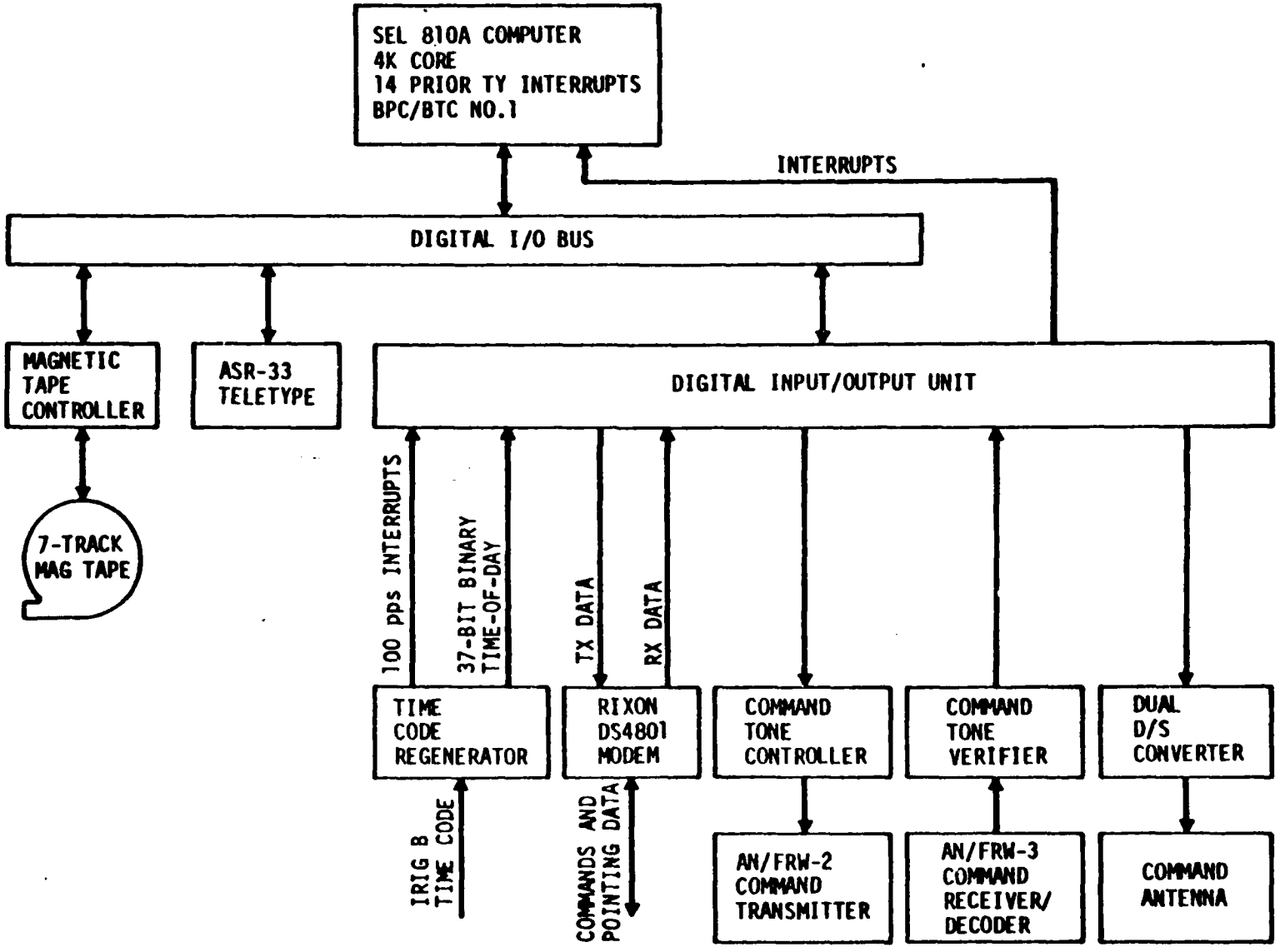
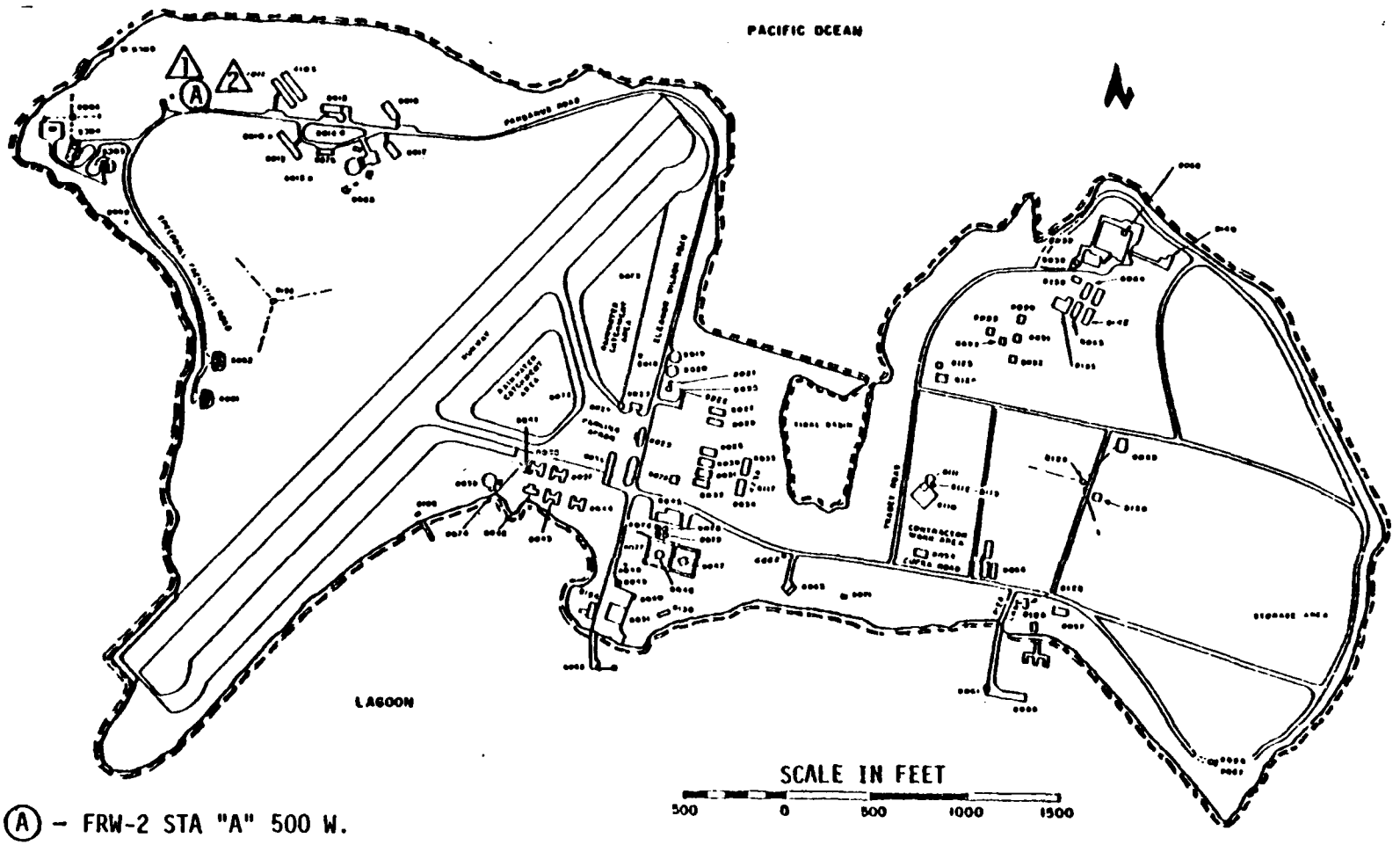


Figure 4-5 AN/FRW-2 Command and Guidance System on Roi-Namur.



(A) - FRW-2 STA "A" 500 W.

1 - FIXED 30° BW VERT x 50° BW HORIZ

2 - BW = 30° HORIZ
BW = 50° VERT

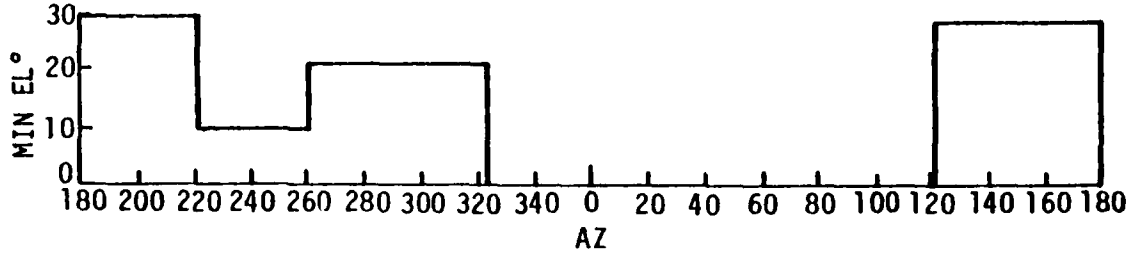


Figure 4-6 CDT Location on Roi-Namur.

4.2.1 Encoder	
4.2.1.1 Description - KY-171/URW	
4.2.1.2 Available Tones	20
4.2.1.3 Number of Simultaneous Tones	5
4.2.1.4 Tone Frequency Tolerance	±1%
4.2.2 RF Source	
4.2.2.1 Description - T-560/FRW-2	
4.2.2.2 Frequency Range	406-549 MHz
4.2.2.3 Assigned Operating Frequency	445/536 MHz
4.2.2.4 Frequency Tolerance (Accuracy and Stability)	±0.01%
4.2.2.5 Deviation Linearity	±5% @ 150 kHz
4.2.2.6 Maximum Modulated Deviation	150 kHz
4.2.2.7 Maximum Residual Modulation	5 kHz
4.2.2.8 Maximum Total Distortion (at Maximum Deviation)	10%
4.2.2.9 Maximum Driver Output	35 W
4.2.3 RF Final	
4.2.3.1 Description - AN/FRW-2	
4.2.3.2 Power Output	500 W
4.2.3.3 Harmonic and Spurious Outputs	-30 dB
4.2.3.4 Bandwidth	3 MHz
4.2.3.5 RF Leakage in Standby Mode	-30 dB
4.2.4 Antennas	
4.2.4.1 Fixed	

4.2.4.1.1	Description - Sterling Colinear Quad Helix	
4.2.4.1.2	Polarization	Left circular
4.2.4.1.3	Gain	14.5 dB/isotropic
4.2.4.1.4	Beamwidth	20°x60°
4.2.4.1.5	Power Rating	10 kW
4.2.4.1.6	Type Feed	Coaxial
4.2.4.1.7	Impedance	50Ω
4.2.4.1.8	Frequency Range	400-550 MHz
4.2.4.1.9	Voltage Standing Wave Ratio (VSWR)	1.5:1
4.2.4.2	Steerable	
4.2.4.2.1	Description - ESCO Tri-Helix	
4.2.4.2.2	Polarization	Left circular
4.2.4.2.3	Gain	14.5 dB
4.2.4.2.4	Beamwidth	18°x30°
4.2.4.2.5	Sidelobes	-12 dB
4.2.4.2.6	Power Rating	15 kW
4.2.4.2.7	Type Feed	Coaxial
4.2.4.2.8	Impedance	50Ω
4.2.4.2.9	Frequency Range	406-550 MHz
4.2.4.2.10	VSWR	1.5:1
4.2.4.2.11	Type Mount, Mfr, Model	EL-AZ ESCO
4.2.4.2.12	Maximum Slew Rates, Azimuth and Elevation	28°/s AZ 12°/s EL
4.2.4.2.13	Positioning Lag	3° max
4.2.4.2.14	Pointing Accuracy	2°

4.2.5 Monitor Receiver

4.2.5.1 Description - R-669A/URW	
4.2.5.2 Frequency Range	406-549 MHz
4.2.5.3 Tuning Method	1-MHz steps

4.2.6 Decoder

4.2.6.1 Description - KY-172/URW	
4.2.6.2 Number of Channels	20
4.2.6.3 Receiver Coupled Threshold Sensitivity	0.64 V rms/tone
4.2.6.4 Channel Bandwidth	±5%
4.2.6.5 Deviation/Input Range	30 kHz/tone

4.2.7 Recording System

4.2.7.1 Description - PEC Model 6860-75 7-track magnetic tape

4.2.7.2 Functions Recorded:

Tones ordered remotely
Tones transmitted
Transmitter radiating
Antenna position
Transmitter fault
Switchover time
Data errors
Parity errors

Chapter 5

NAVAL WEAPONS CENTER (NWC)
CHINA LAKE, CALIFORNIA

5.0 Naval Weapons Center (NWC) System

The NWC system consists of four transmitting sites; two stationary and two mobile. These are located as shown in figure 5-1. The mobile sites have been selected to optimize coverage for the range but can be relocated, if required, to accommodate special needs of particular programs. Further, the system can be used for control functions other than destruct, with permission.

Each site has omnidirectional antennas and dual transmitters with automatic switchover in case of failure. Event recorders identify the radiating transmitter and tones ordered.

Control of radiation and modulation is manually effected at each site and is under the direction of the Range Safety Officer who exercises direct control of site 1 from the Flight Termination Console in Building 30855. Assistant Range Safety Officers are stationed at each site which is active for a mission.

Site geodetics are as follows:

	LATITUDE	LONGITUDE	ELEVATION
Site 1	35°41'53.2"	117°37'25.0"	2177 ft m.s.l.
Site 2	35°46'29.8"	117°46'38.1"	2270 ft m.s.l.

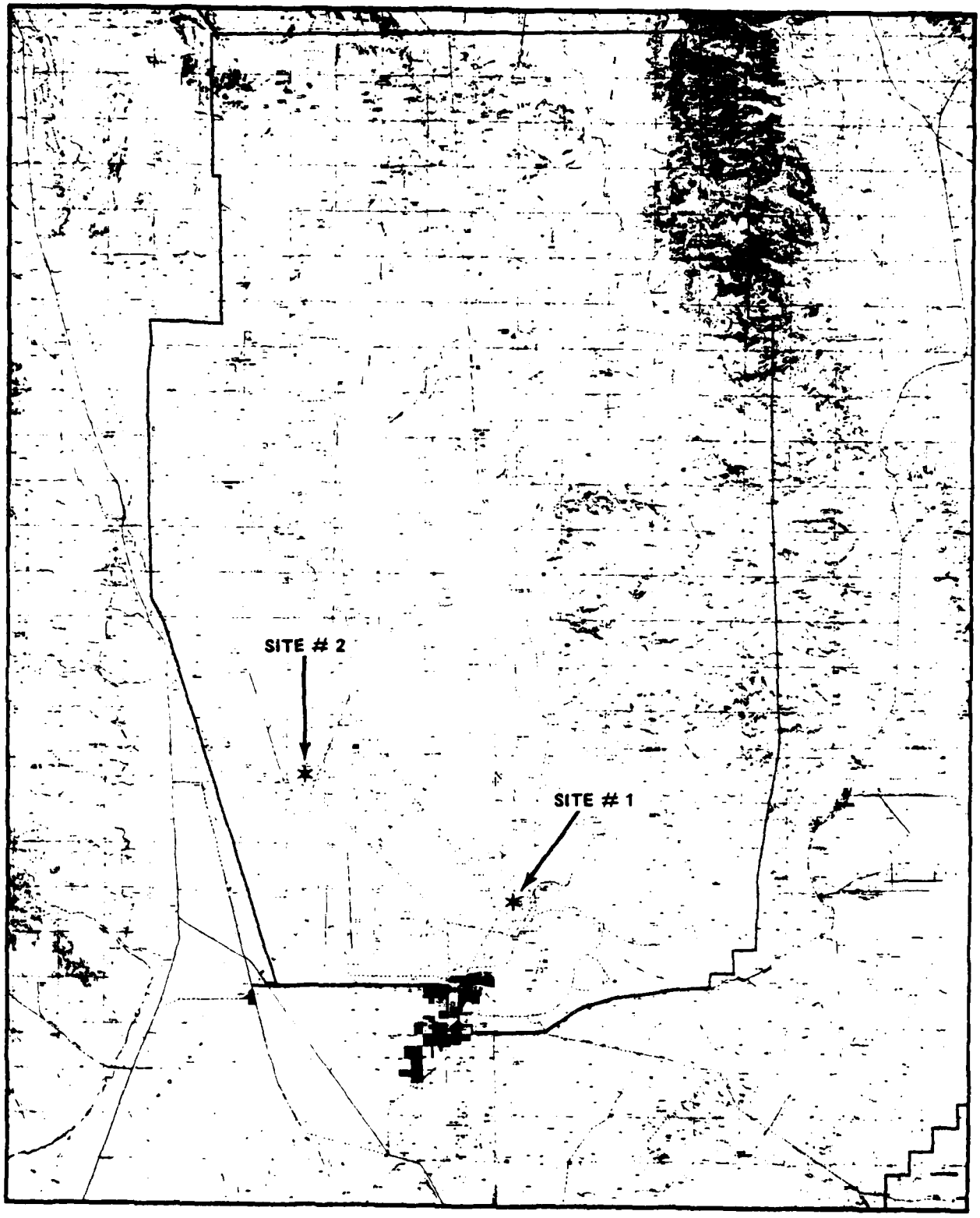
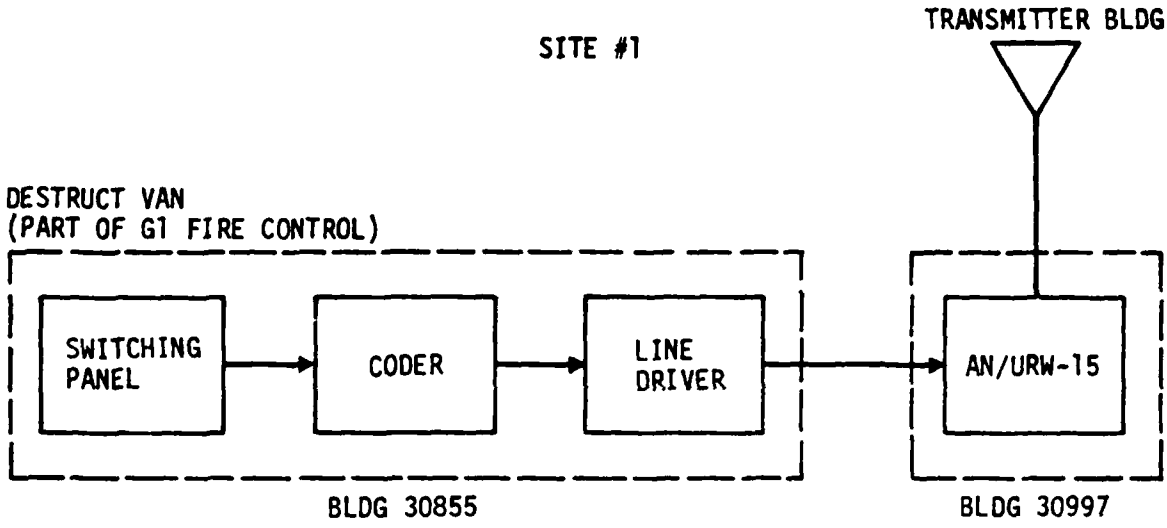


Figure 5-1 Command Transmitters at NWC.

5.1 Stationary Sites 1 and 2

The stationary sites are basically assembled from AN/URW-15 equipment. As shown in figure 5-2, the coders and control equipment are located in the fire control centers, while the transmitters themselves are located in adjacent facilities. Sites are linked together by voice communication. Each of the stations provides coverage of approximately 80 percent of the NWC airspace. Commercial and local generator power is provided to them as shown in figure 5-3.



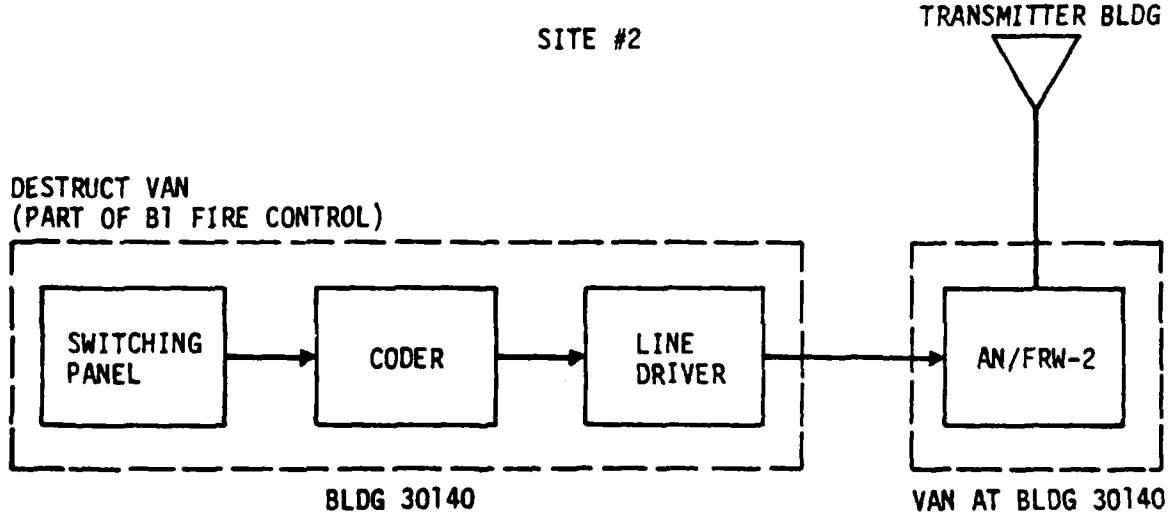


Figure 5-2 Sites 1 and 2 Transmitter Configurations.

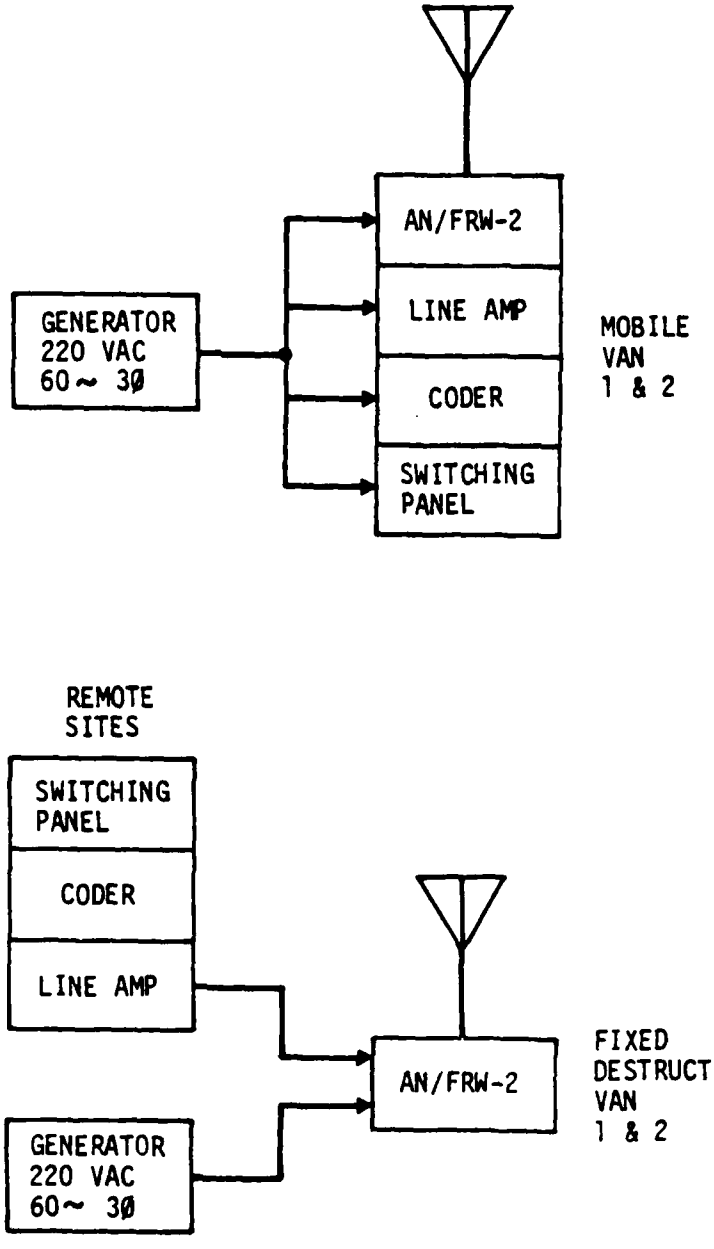


Figure 5-3 Transmitter Block Diagram at Sites 1 and 2.

5.1.1 Encoder	
5.1.1.1 Description - Part of AN/URW-14A	
5.1.1.2 Available Tones	20
5.1.1.3 Number of Simultaneous Tones	6
5.1.1.4 Tone Frequency Tolerance	±1%
5.1.1.5 Tone Off Level	0
5.1.2 RF Source	
5.1.2.1 Description - AN/URW-14A	
5.1.2.2 Frequency Range	406-549.5 MHz
5.1.2.3 Assigned Operating Frequency	424/439 MHz
5.1.2.4 Frequency Tolerance (Accuracy and Stability)	0.005%
5.1.2.5 Maximum Modulated Deviation	±300 kHz
5.1.2.6 Maximum Total Distortion (at Maximum Deviation)	<3%
5.1.2.7 Maximum Driver Output	75 W
5.1.2.8 Maximum Residual Modulation	<5 kHz
5.1.3 RF Final	
5.1.3.1 Description - AN-2643 (AN/URW-15)	
5.1.3.2 Power Output	>500 W <1 kW
5.1.3.3 Bandwidth	406-549.5 MHz
5.1.4 Antennas	
5.1.4.1 Fixed	
5.1.4.1.1 Description - Gabriel AT-571 A/U	
5.1.4.1.2 Polarization	Left circular
5.1.4.1.3 Gain	5 dB

5.1.4.1.4 Beamwidth	Omni
5.1.4.1.5 Power Rating	1 kW
5.1.4.1.6 Impedance	50Ω
5.1.4.1.7 Frequency Range	400-550 MHz
5.1.4.1.8 Voltage Standing Wave Ratio (VSWR)	<1.8:1

5.1.4.2 Steerable

5.1.4.2.1 Description - None available.

5.1.5 Monitor Receiver

5.1.5.1 Description - AN/URW-16	
5.1.5.2 Frequency Range	406-549.5 MHz
5.1.5.3 Tuning Method	Crystal
5.1.5.4 Modulated Band Pass (6 dB)	1.4-2.0 MHz
5.1.5.5 RF Sensitivity	5μV
5.1.5.6 Audio Output Level	1.4-7 V peak

5.1.6 Decoder

5.1.6.1. Description - Part of AN/URW-16	
5.1.6.2 Number of Channels	20
5.1.6.3 Receiver Coupled Threshold Sensitivity	5μV
5.1.6.4 Deviation/Input Range	Up to 300 kHz
5.1.6.5 Command Output Response Time	15 ms max

5.1.7 Recording System

5.1.7.1 Description - Event recorders

5.1.7.2 Functions Recorded:

Tones transmitted
Transmitter radiating

5.2 Mobile Relocatable Sites

Mobile sites are provided with generator power permitting them to be located wherever they are required. Both modulation control and signal generation are colocated in a single van. Though not currently configured for remote control, the basic design permits such operation over land lines.

5.2.1 Encoder

5.2.1.1 Description - KY-171	
5.2.1.2 Available Tones	20
5.2.1.3 Number of Simultaneous Tones	6
5.2.1.4 Tone Frequency Tolerance	±1%
5.2.1.5 Tone Off Level	0

5.2.2 RF Source

5.2.2.1 Description - AN/FRW-2	
5.2.2.2 Frequency Range	406-549 MHz
5.2.2.3 Frequency Tolerance (Accuracy and Stability)	0.01%
5.2.2.4 Maximum Modulated Deviation	±300 kHz
5.2.2.5 Maximum Total Distortion (at Maximum Deviation)	3.5%
5.2.2.6 Maximum Driver Output	≥25 W
5.2.2.7 Maximum Residual Modulation	<5 kHz

5.2.3 RF Final

5.2.3.1 Description - AN/FRW-2	
5.2.3.2 Power Output	>500W <1 kW
5.2.3.3 Bandwidth	406-549 MHz

5.2.4 Antennas

5.2.4.1 Fixed

5.2.4.1.1 Description - Gabriel AT-751/U	
5.2.4.1.2 Polarization	Left circular
5.2.4.1.3 Gain	5 dB
5.2.4.1.4 Beamwidth	Omni
5.2.4.1.5 Power Rating	1 kW
5.2.4.1.6 Impedance	50Ω
5.2.4.1.7 Frequency Range	400-550 MHz
5.2.4.1.8 VSWR	<1.8:1

5.2.4.2 Steerable

5.2.4.2.1 Description - None available

5.2.5 Monitor Receiver

5.2.5.1 Description - R669A/URW	
5.2.5.2 Frequency Range	406-549 MHz
5.2.5.3 Tuning Method	Crystal
5.2.5.4 Modulated Band Pass (6 dB)	1.4-2.0 MHz
5.2.5.5 RF Sensitivity	0.05 V
5.2.5.6 Audio Output Level	2 V

5.2.6 Decoder

5.2.6.1 Description - Part of R669A/URW	
5.2.6.2 Number of Channels	20
5.2.6.3 Receiver Coupled Threshold Sensitivity	2 V

5.2.6.4 Command Output Response Time >15 ms

5.2.7 Recording System

5.2.7.1 Description - Event recorders

5.2.7.2 Functions Recorded:

Tones ordered remotely
Tones transmitted

Chapter 6

PACIFIC MISSILE TEST CENTER (PMTC)
POINT MUGU, CALIFORNIA

6.0 Pacific Missile Test Center (PMTC) System

The PMTC system consists of three Command Control Transmitter (CCT) sites. These are located at Laguna Peak, San Nicolas Island (SNI) and Barking Sands, Kauai, Hawaii (figures 6-1 and 6-2). The Laguna Peak and SNI sites are fixed stations, while the Barking Sands site utilizes mobile vans. All the sites employ the AN/FRW-2 UHF transmitter and are configured for manual or automatic fail-over capability. The Laguna Peak and SNI stations may be configured to operate independently or chained together so that control can be passed from one to the other as the mission progresses.

The Laguna Peak site has four dual transmitter systems, two local control directional antennas, six Gabriel model AT-781/u omni antennas, four model AT-286000 corner reflectors, and a local control station. The CCTs and the antennas interface into a coaxial patch panel allowing any transmitter to interface with any antenna.

The directional antennas are designed for continuous rotation in azimuth and 90° in elevation. They are Left Hand Circular Polarized (LHCP) with a 16-dB gain and a beamwidth of 15°. The Gabriel model AT-781/u omni antennas are LHCP with a 5-dB gain. The corner reflector model AT-286000 antennas are vertically polarized with a 10-dB gain and a beamwidth of 65°.

Transmitter control and modulation can be directed locally, or by remote control from the Tracking and Control (T&C) rooms in Building 53 via communications land lines. There are six control stations in Building 53 equipped with a 20-channel coder. Each can monitor the transmitter status and off-the-air tone transmissions. The transmitter signals are also monitored at the transmitter site by a self-contained RF monitor and decoder combination.

The SNI site has two dual transmitter systems, one directional antenna, two Gabriel model AT-781/u omni antennas, and one Gabriel model AT-782/u omni antenna. The directional antenna is interfaced with the Sensor Positioning and Readback System (SPARS) and can be slaved to the radars or telemetry. The directional antenna and the Gabriel model AT-781/u antenna have the same specifications as those on Laguna Peak. The Gabriel model AT-782/u omni antenna is LHCP with a 10-dB gain.

The SNI site is remotely controlled from the T&C rooms in Building 53 via the Kinplex and wide band microwave system. Monitoring of

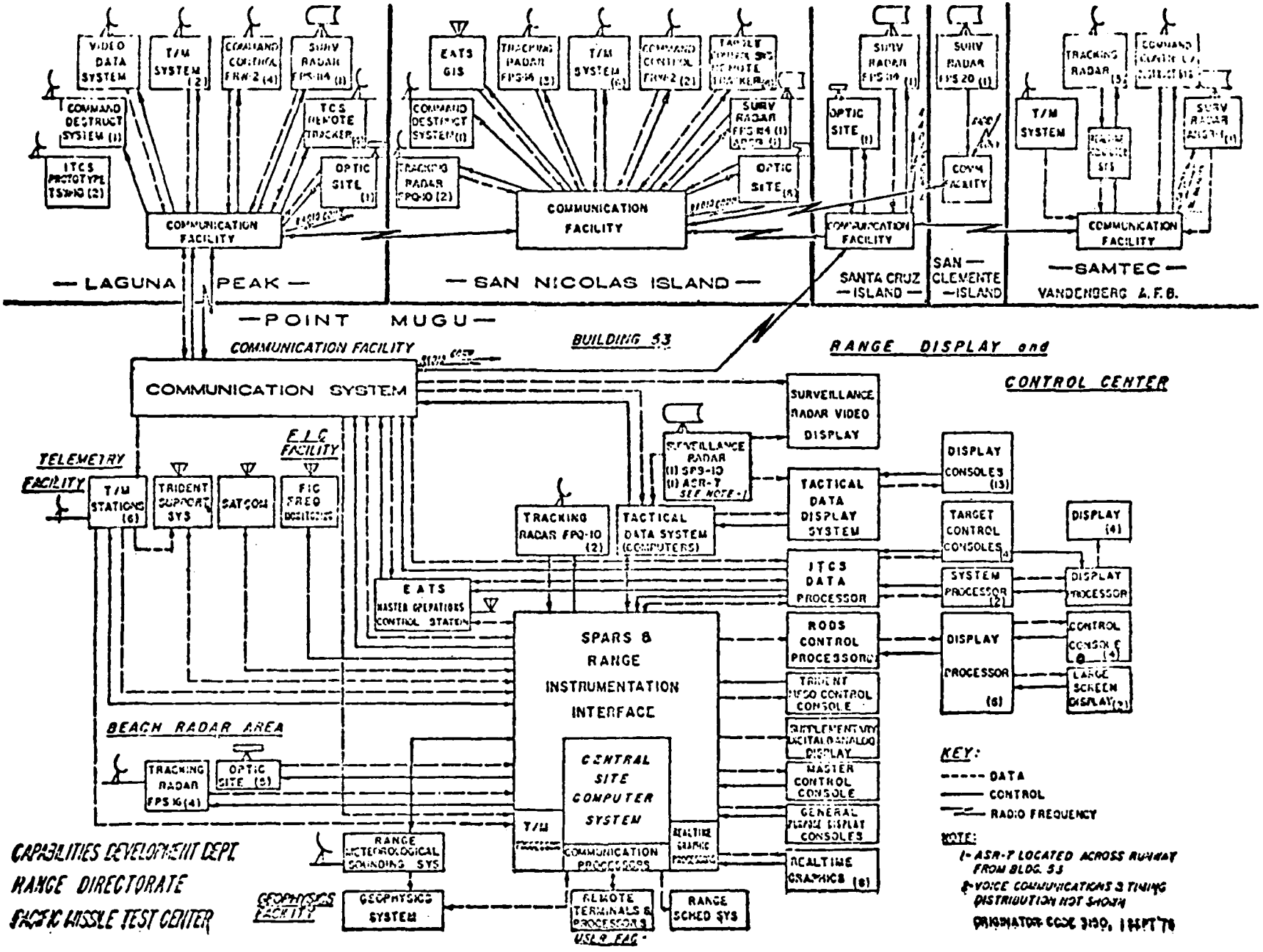


Figure 6-1 Range System Functional Diagram.

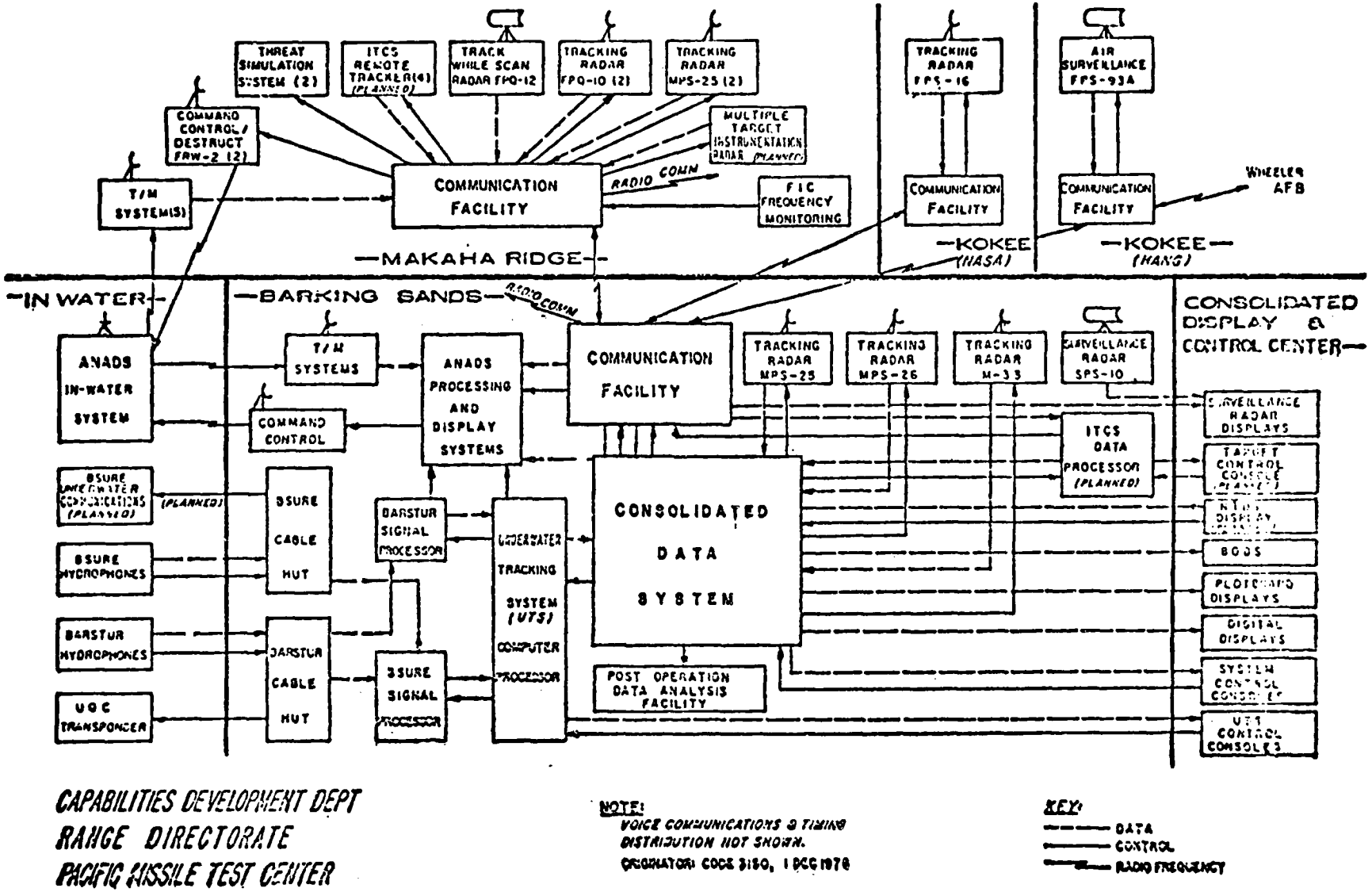


Figure 6-2 Range System Functional Diagram - Hawaiian Area.

transmitter status and tone transmissions is provided in the T&C rooms. The two systems on SNI can be used in conjunction with the four systems on Laguna Peak to provide a six-target control capability.

The Barking Sands site is located on Makaha Ridge. It has two dual transmitter systems, two local control directional antennas, one Gabriel model AT-781/u omni antenna, and one Gabriel model AT-782/u omni antenna. The antenna specifications are the same as those for Laguna Peak and SNI.

The site is remotely controlled from the Range Control Center in Building 105 via FSK and four wide band microwave channels. The system is similar to and operates the same as the SNI system.

The geodetic location of the sites is as follows:

	LATITUDE	LONGITUDE	ELEVATION
Laguna Peak	34°6'27"N	119°3'57"W	1420 ft m.s.l.
San Nicolas Island	33°14'56.1"N	119°31'16.5"W	850 ft m.s.l.
Barking Sands	22°7'30"N	159°44'20"W	1500 ft m.s.l.

6.1 Site Descriptions

The sites operate from commercial a.c. power with standby backup generators. The Laguna Peak transmitters are located in Building 93 and are connected in a fail-over arrangement. If the primary transmitter fails due to low incident power or high reflected power, the B+ power is applied to the backup transmitter. The backup system then assumes control of the command/destruct functions. Block diagrams of the system are provided in figures 6-3, 6-4 and 6-5.

The SNI transmitters are located in Building 127. The system works the same as that at Laguna Peak. A block diagram of the system is shown in figure 6-6.

The Barking Sands transmitters are housed in mobile vans located on Makaha Ridge. They operate the same as those at SNI. Block diagrams of the system are shown in figures 6-7, 6-8 and 6-9.

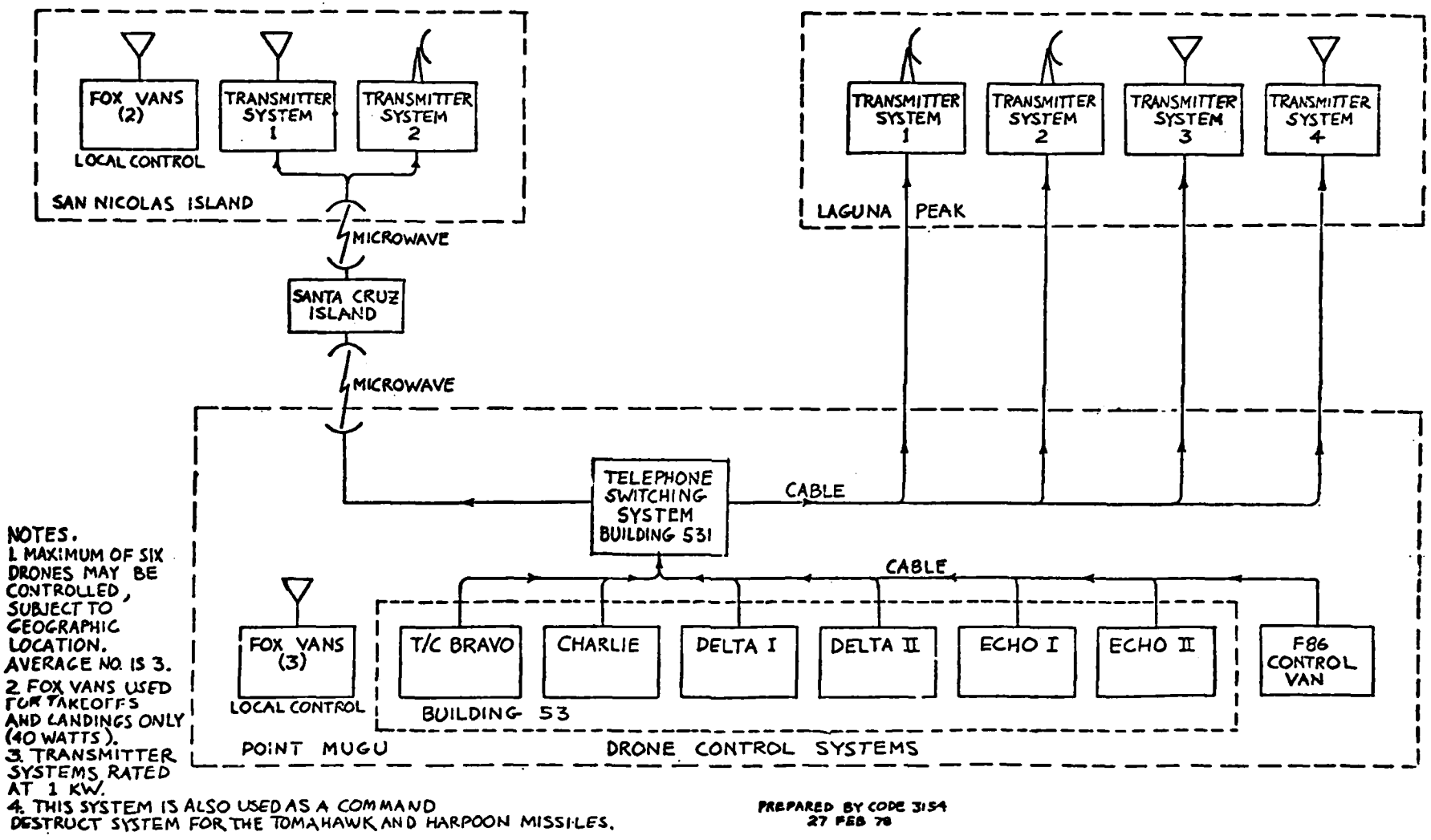


Figure 6-3 Block Diagram of Command Control System.

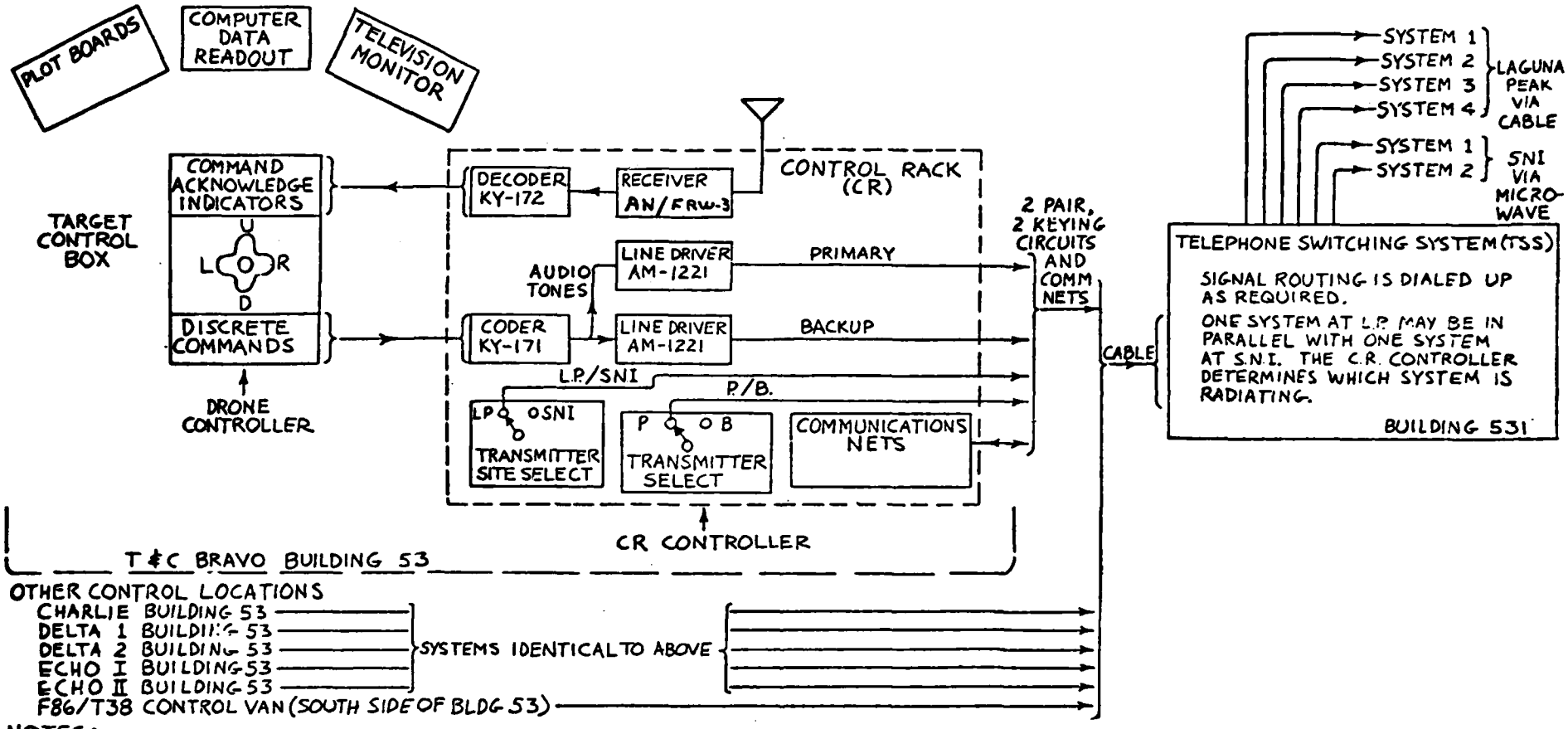
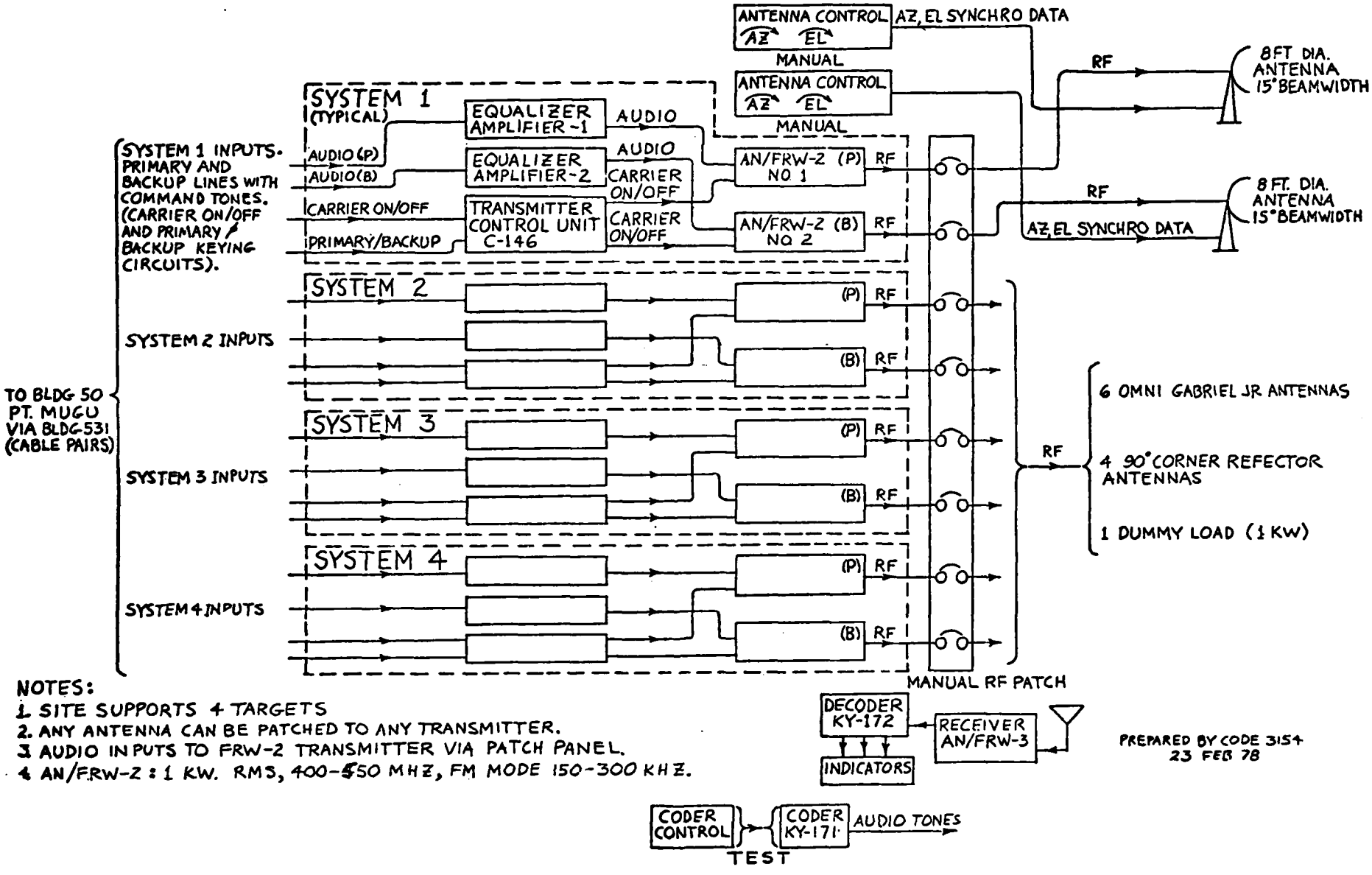


Figure 6-4 Command Control System at Point Mugu.



NOTES:

1. SITE SUPPORTS 4 TARGETS
2. ANY ANTENNA CAN BE PATCHED TO ANY TRANSMITTER.
3. AUDIO INPUTS TO FRW-2 TRANSMITTER VIA PATCH PANEL.
4. AN/FRW-2 : 1 KW. RMS, 400-450 MHZ, FM MODE 150-300 KHZ.

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Figure 6-5 Command Control System at Laguna Peak.

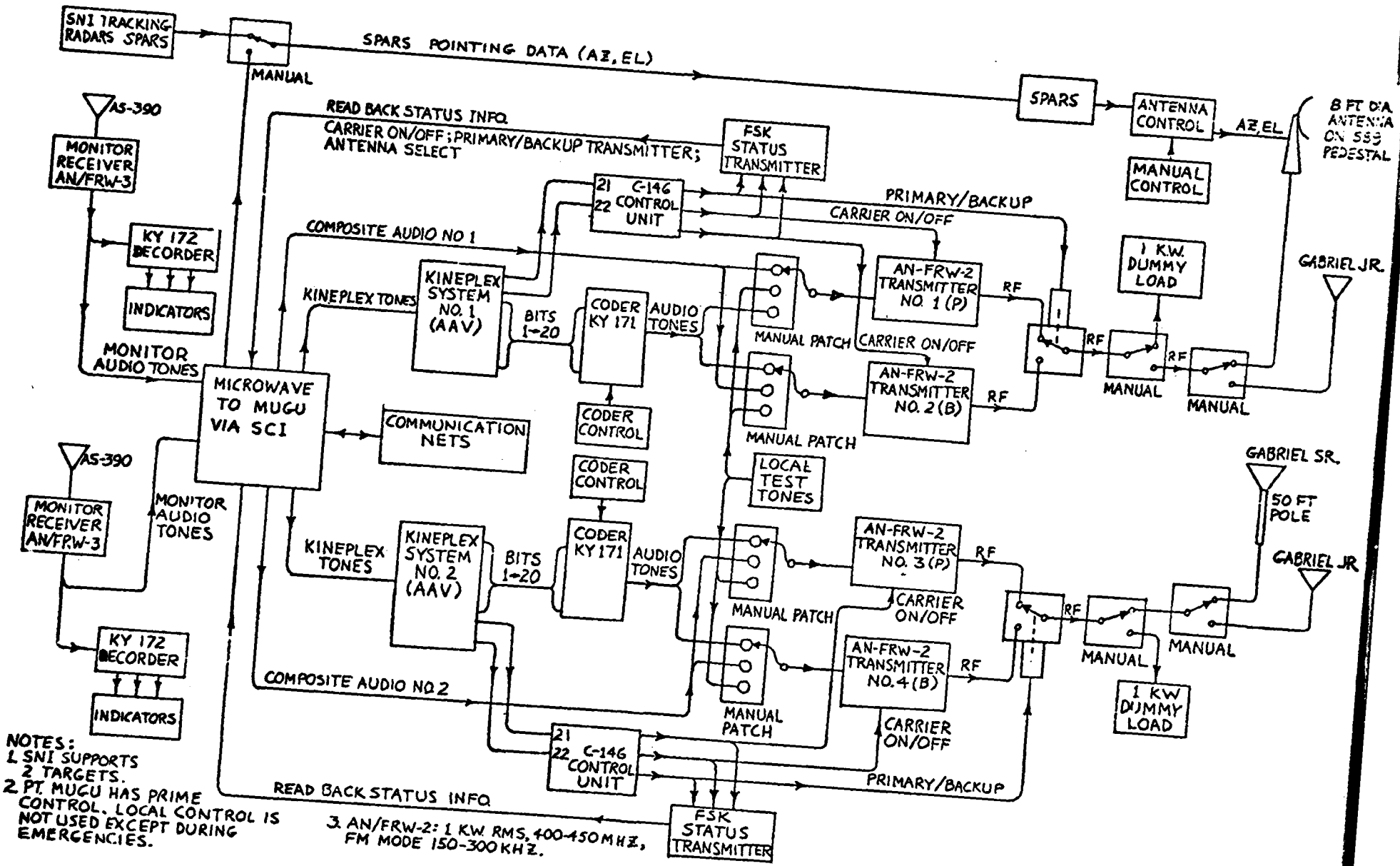
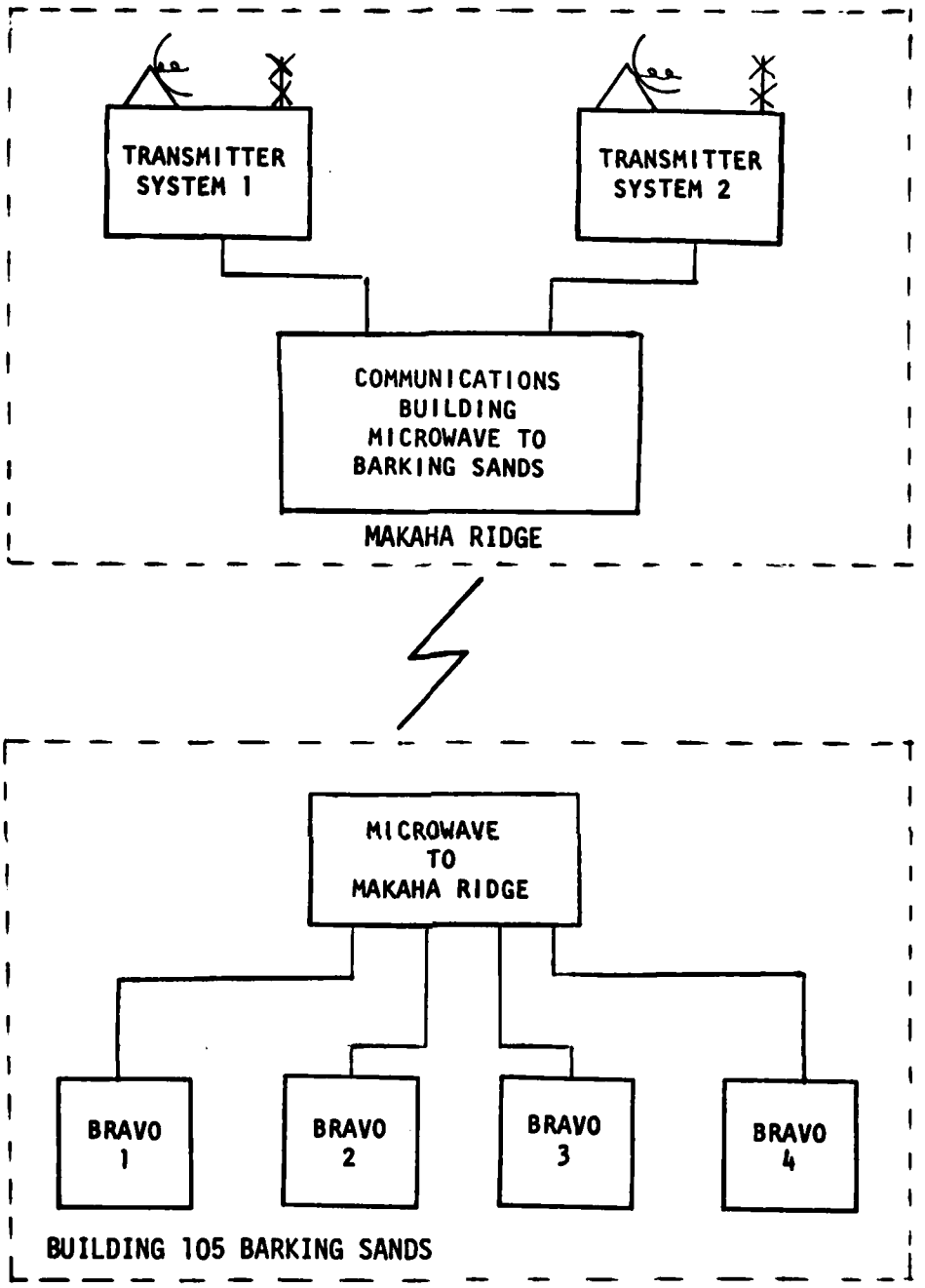


Figure 6-6 Command Control System at San Nicolas Island.



NOTES:
1. *Maximum of four targets (two airborne, two AVR) may be controlled simultaneously.*
2. *Transmitter system rated at 1 kW.*
3. *This system is also used as a command destruct system for the TOMAHAWK, standard ARM, and HARPOON missiles.*

Figure 6-7 Block Diagram of the Command Control System at Barking Sands.

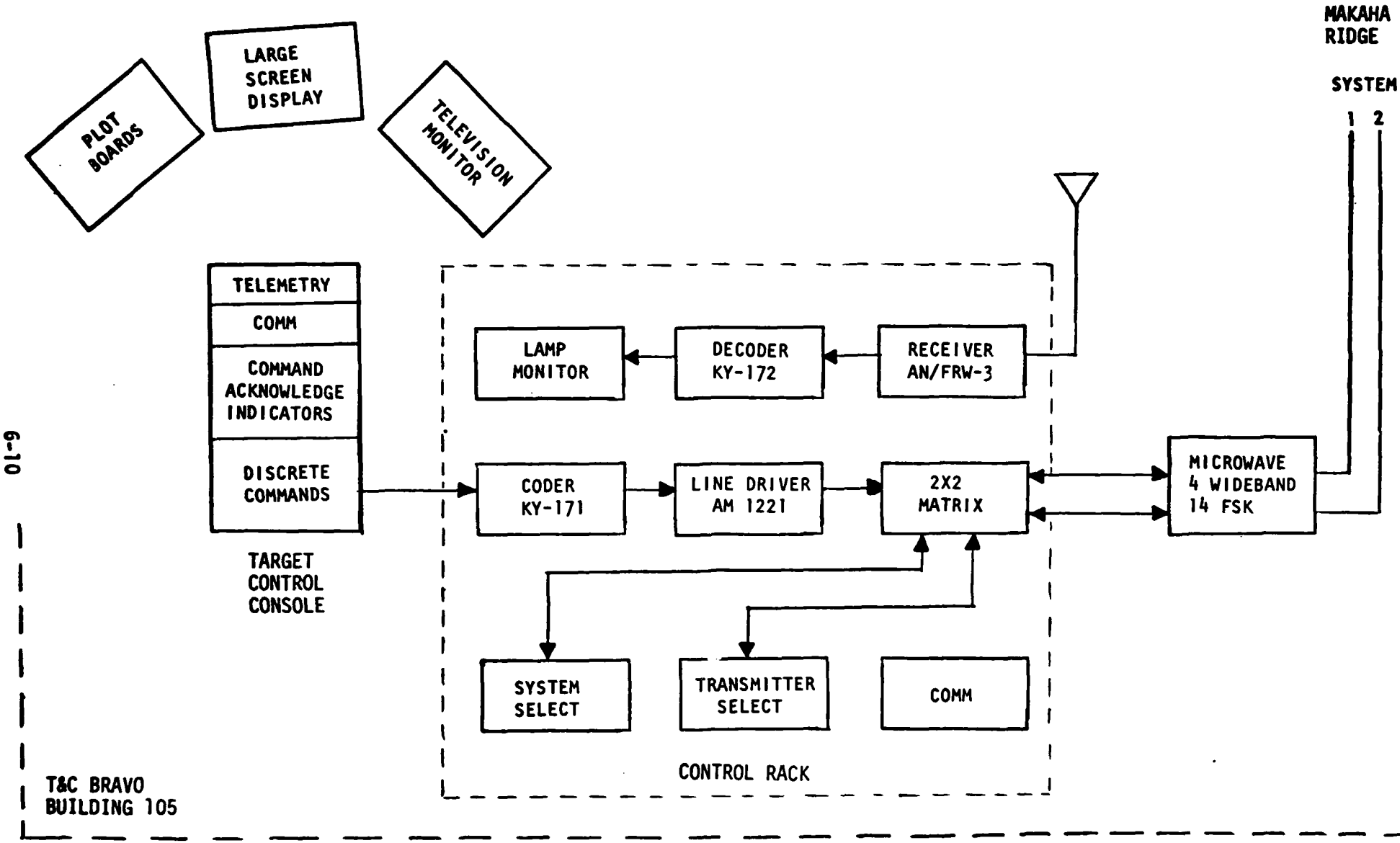
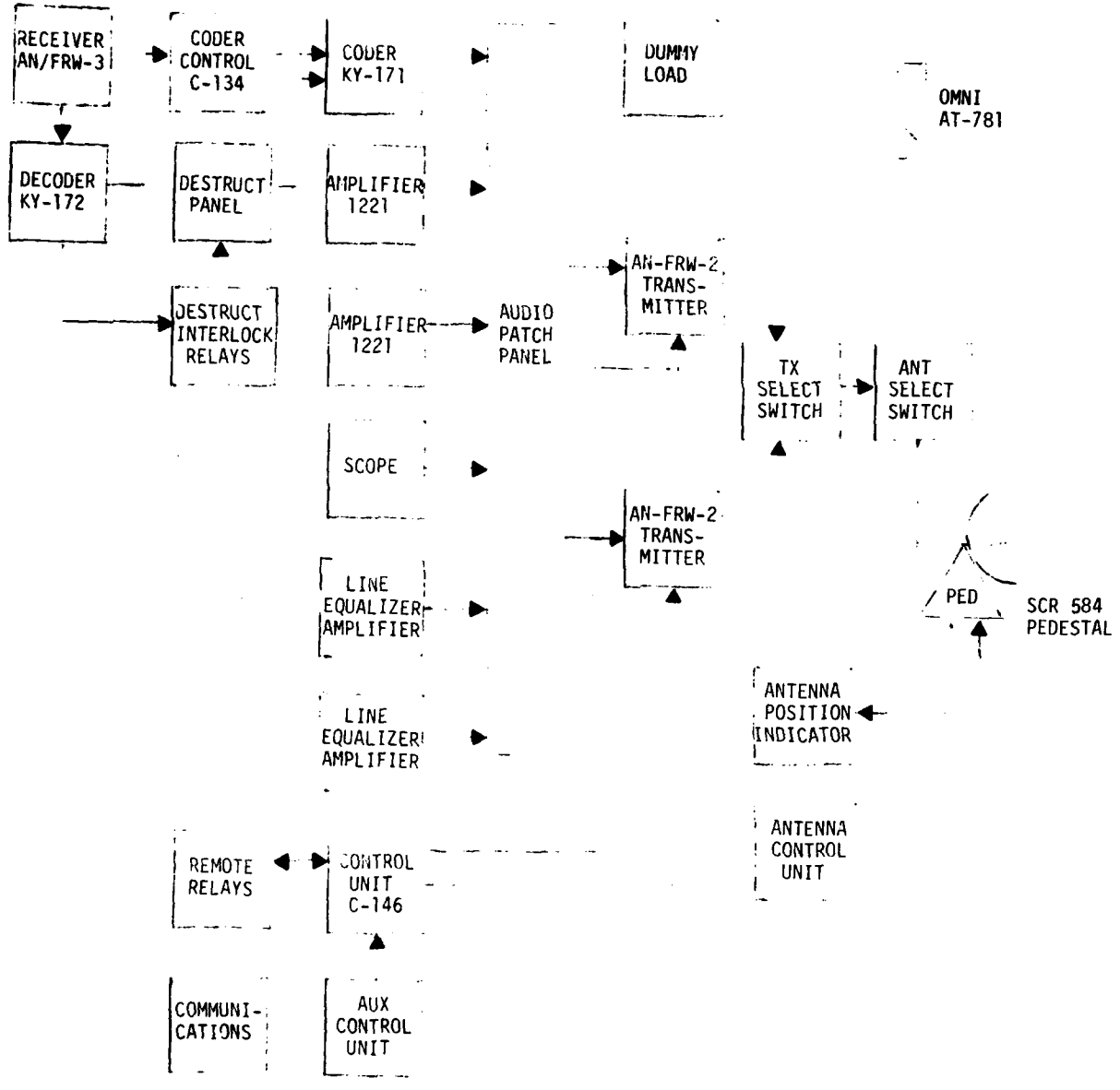


Figure 6-8 Command Control System at Barking Sands.



NOTE: System 2 same as system 1.

Figure 6-9 Command Control System at Barking Sands.

6.1.1 Encoder	
6.1.1.1 Description - KY-171/URW	
6.1.1.2 Available Tones	20
6.1.1.3 Number of Simultaneous Tones	6
6.1.1.4 Tone Frequency Tolerance	±0.5% max
6.1.1.5 Distortion	1% max
6.1.1.6 Composite Signal Amplitude Stability	±10%
6.1.1.7 Tone Off Level	-36 dB
6.1.1.8 Turn On Delay Time (to 90-Percent Level)	1.0 ms
6.1.1.9 Turn Off Delay Time	1.0 ms
6.1.1.10 Composite Transient Output (Switching)	1 mW
6.1.1.11 Command Function Tone Balance	±1 dB
6.1.2 RF Source	
6.1.2.1 Description - T-560/FRW-2	
6.1.2.2 Frequency Range	406-549 MHz
6.1.2.3 Frequency Tolerance (Accuracy and Stability)	±0.01%
6.1.2.4 Deviation Linearity	±5%
6.1.2.5 Maximum Modulated Deviation	±300 kHz
6.1.2.6 Maximum Residual Modulation	±2 kHz
6.1.2.7 Maximum Total Distortion (at Maximum Deviation)	2%
6.1.2.8 Maximum Driver Output	50 W
6.1.3 RF Final	
6.1.3.1 Description - AN/FRW-2	
6.1.3.2 Power Output	500 W

6.1.3.3 Harmonic and Spurious Outputs	-35 dB harmonic -75 dB spurious
6.1.3.4 Bandwidth	1 MHz
6.1.3.5 RF Leakage in Standby Mode	5.97 e-12 W/m^2, >6 kft
6.1.4 Antennas	
6.1.4.1 Fixed	
6.1.4.1.1 Description - Gabriel AT-781/u	
6.1.4.1.2 Polarization	Left circular
6.1.4.1.3 Gain	5 dB
6.1.4.1.4 Beamwidth	Omni d/h=5:1
6.1.4.1.5 Power Rating	1 kW
6.1.4.1.6 Type Feed	LC
6.1.4.1.7 Impedance	50Ω
6.1.4.1.8 Frequency Range	406-500 MHz
6.1.4.1.9 Voltage Standing Wave Ratio (VSWR)	1.75:1 max
6.1.4.2. Steerable	
6.1.4.2.1 Description	
6.1.4.2.2 Polarization	Left circular
6.1.4.2.3 Gain	16 dB
6.1.4.2.4 Beamwidth	18°
6.1.4.2.5 Sidelobes	-14 dB
6.1.4.2.6 Power Rating	1 kW
6.1.4.2.7 Type Feed	Helix
6.1.4.2.8 Impedance	50Ω

6.1.4.2.9 Frequency Range	406-550 MHz
6.1.4.2.10 VSWR	2:1
6.1.4.2.11 Type Mount, Manufacturer, Model	Mp-61 modified
6.1.4.2.12 Maximum Slew Rates, Azimuth and Elevation	45°/s
6.1.4.2.13 Positioning Lag	10°/s
6.1.5 Monitor Receiver	
6.1.5.1 Description - R-729/FRW-3 and R-669/URW	
6.1.5.2 Frequency Range	406-549 MHz
6.1.5.3 Tuning Method	1-MHz steps
6.1.5.4 Modulated Band Pass (3 dB)	600 kHz
6.1.5.5 Antenna Type and Characteristics	As-390 omni
6.1.5.6 RF Sensitivity	5μ V
6.1.5.7 Audio Output Level	0-5 V
6.1.5.8 Audio Output Bandwidth	1 MHz
6.1.6 Decoder	
6.1.6.1 Description - KY-172	
6.1.6.2 Number of Channels	20
6.1.6.3 Receiver Coupled Threshold Sensitivity	200 mV
6.1.6.4 Channel Bandwidth	3-5% of 6 dB-point
6.1.6.5 Deviation/Input Range	20 kHz
6.1.6.6 Command Output Response Time	30 ms
6.1.7 Recording System	
6.1.7.1 Description - Esterline Angus	
6.1.7.2 Functions Recorded:	Audio tones
Tones Transmitted	20

Chapter 7

WESTERN SPACE AND MISSILE CENTER (WSMC)
VANDENBERG AFB, CA

7.0 Missile Flight Termination Control Ground System (MFTCGS) General Description

WSMC has four Command Control Transmitters (CCT) located as shown in figure 7-1. Figure 7-2 shows typical launch trajectory area coverage. Of the four CCT sites, two are located on Vandenberg AFB (figures 7-3 and 7-4) with both fixed omnidirectional and steerable directional antennas. The other two are remote sites with steerable directional antennas only. One is located at Pillar Point (figure 7-5), just south of San Francisco, while the other site is located at Laguna Peak (figure 7-6) near Point Mugu U.S. Naval Air Station.

The description in this document pertains only to use of the MFTCGS in support of safety functions. Agreements, however, may be made for the use of this system in support of drone command, satellite command and other nonsafety command functions, provided missile flight safety is given the first order of precedence. Furthermore, if system capabilities are incorporated for purposes other than missile flight termination, the end result will effect no degradation in the capability of the MFTCGS to meet all the requirements for missile flight safety purposes.

At liftoff, support is provided by one of the Vandenberg-located sites in the omnidirectional antenna configuration. At some predetermined time, the antenna configuration is automatically changed from the omnidirectional to the steerable directional antenna. At some later predetermined time, the local site is deactivated and one of the remote sites is activated to provide a better look angle for improved RF illumination. The Pillar Point site is used primarily for westerly ballistic launches and the Laguna Peak site for southerly orbital launches.

Each site is configured with redundant transmitters. During launch, one transmitter is selected as prime with the other transmitter in standby configuration. A station guardian system automatically switches from the prime to the standby transmitter if a condition of high reflected power or low incident power occurs.

During missile flight, the steerable directional antenna is normally operated in the automatic slaving mode from point data provided by the real-time metric data system. In the case of data loss, the antenna can be directed to predetermined azimuth and elevation settings by the site operator.

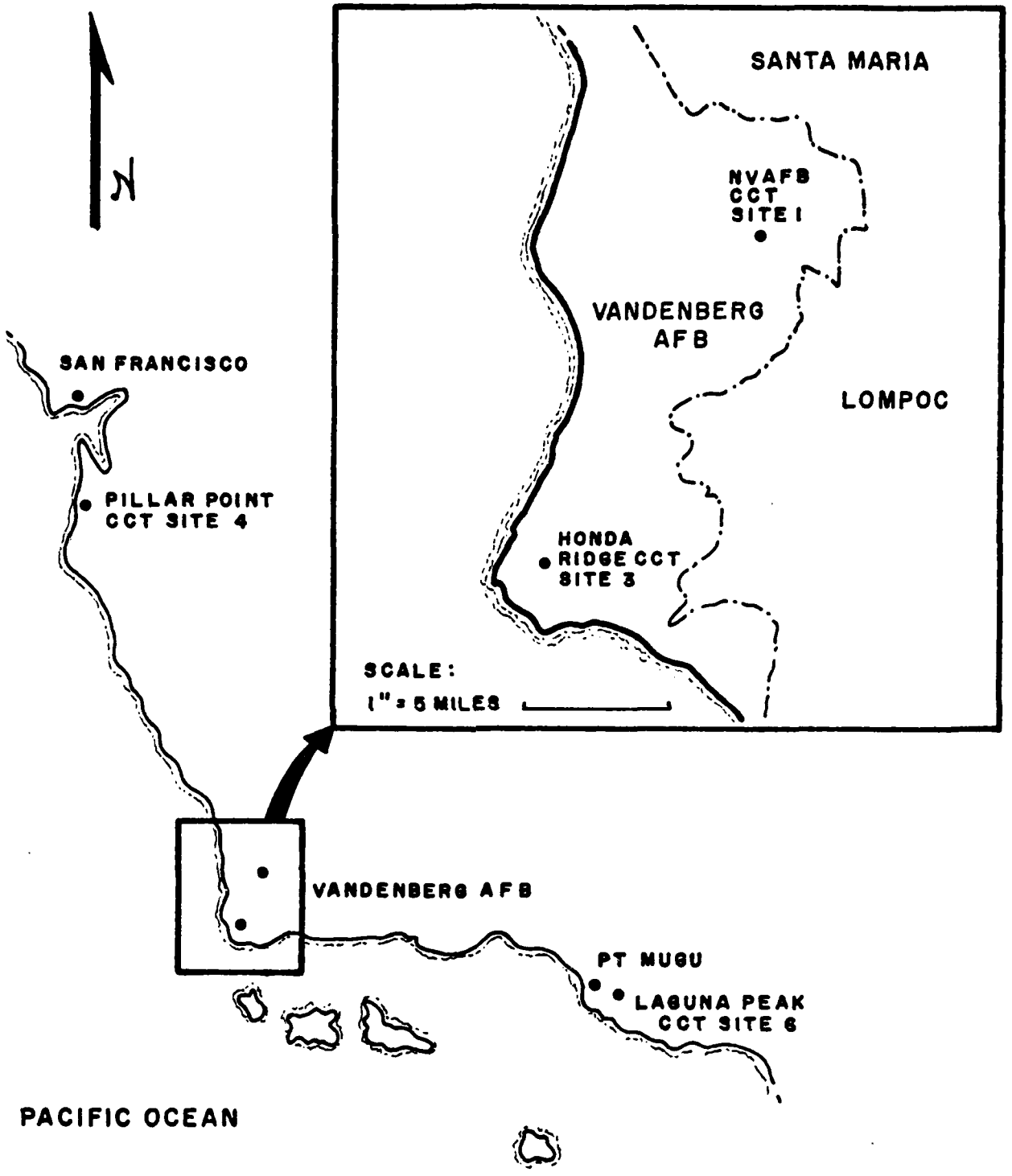


Figure 7-1 Command Control Transmitter Sites at WSMC.

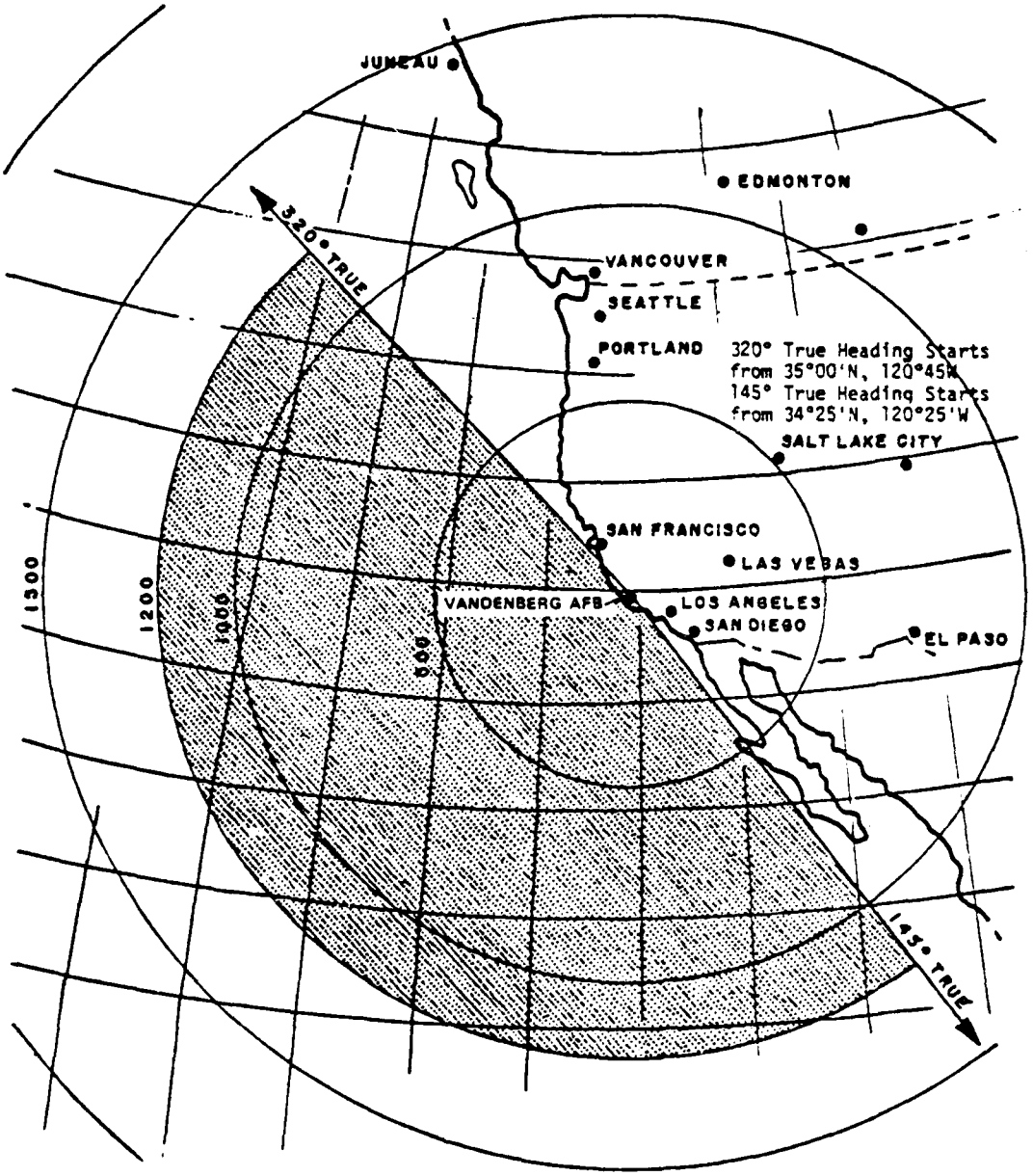


Figure 7-2 Launch Trajectory Area Coverage at WSMC.

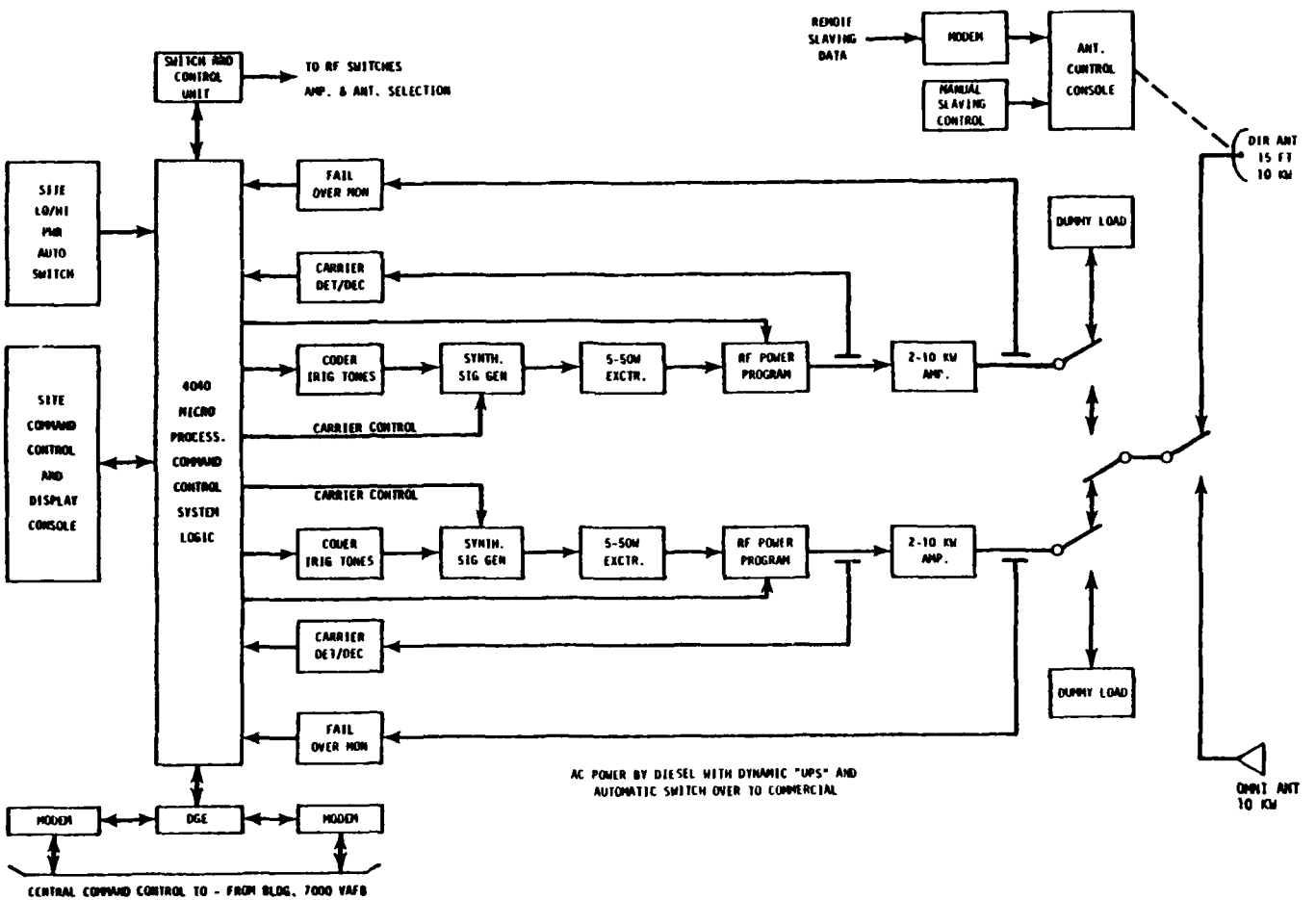


Figure 7-3 CCT Site 1 at NVAFB.

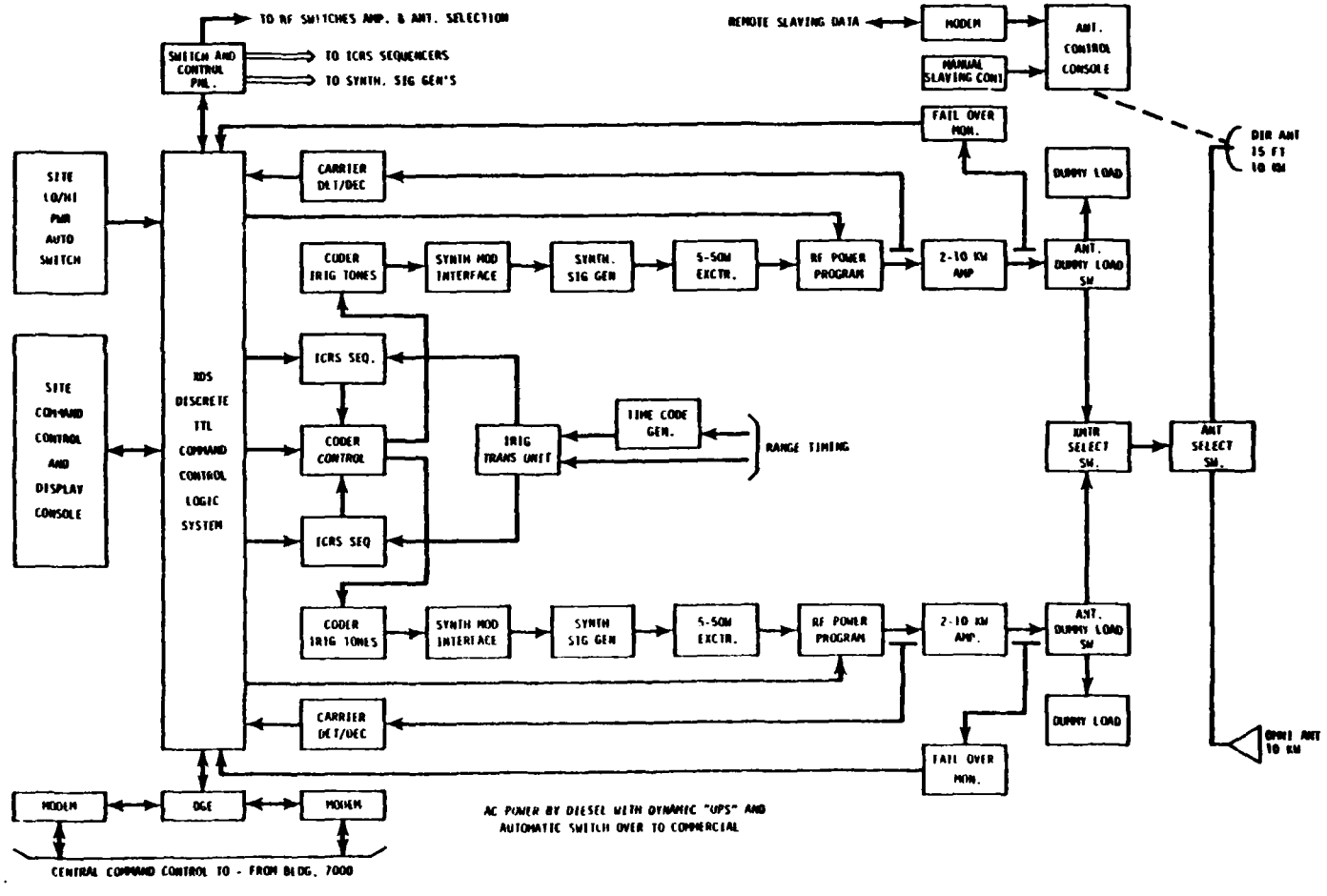


Figure 7-4 CCT Site 3 at SVAFB.

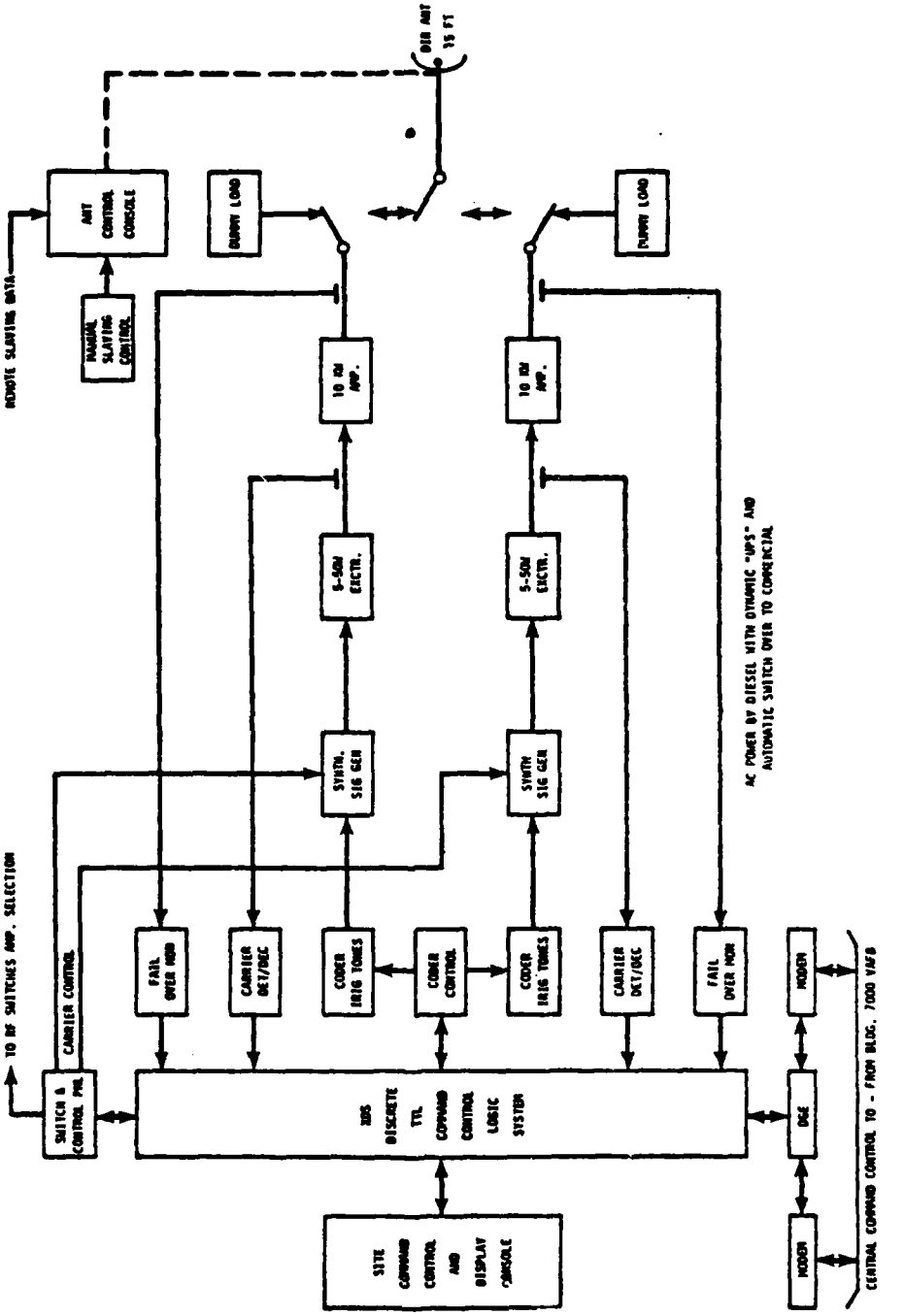


Figure 7-5 CCT Site 4 at Pillar Point.

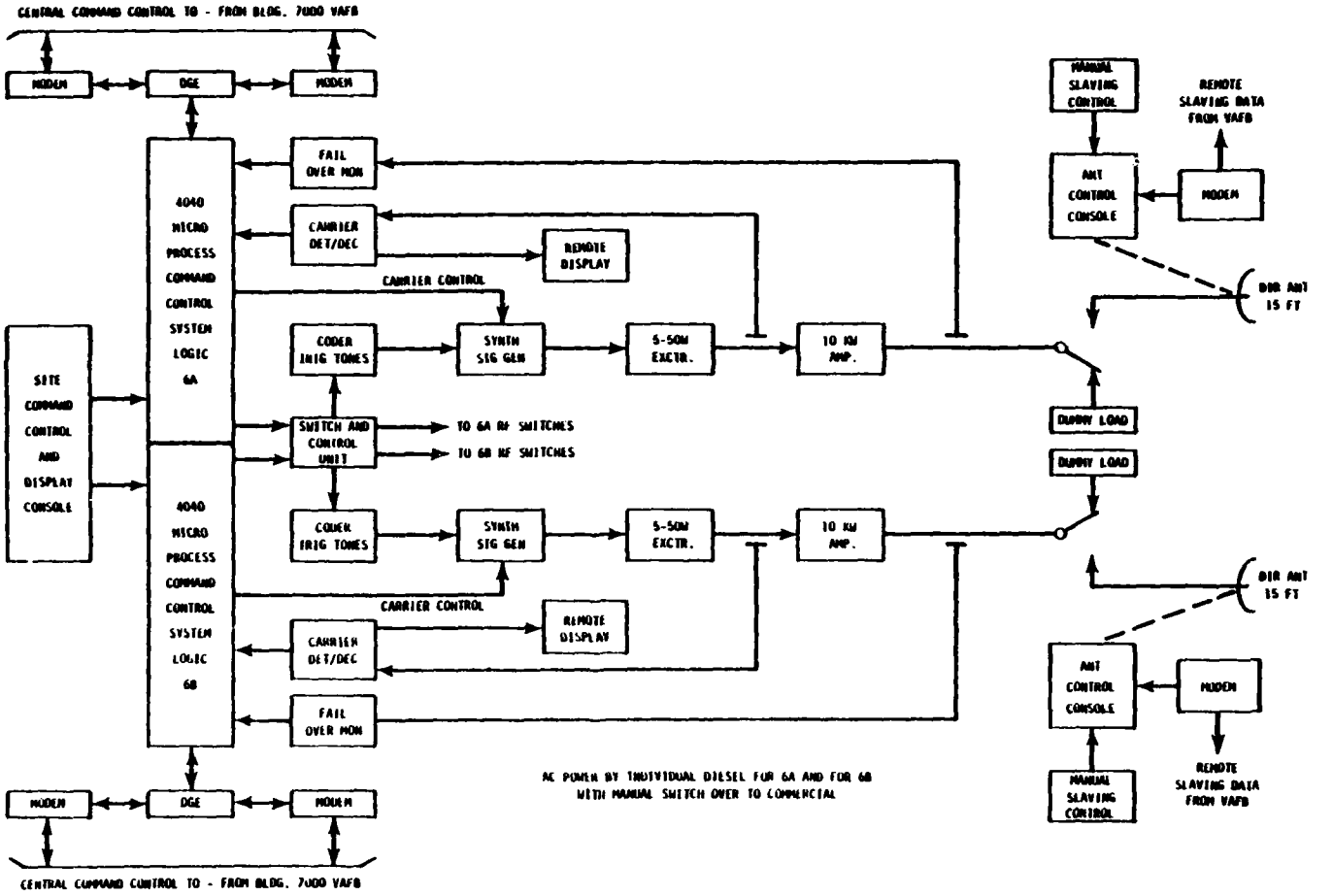


Figure 7-6 CCT Site 6 at Laguna Peak, Point Mugu.

During missile flight, the CCT sites are centrally controlled and monitored from the Missile Flight Control Center (MFCC) at Vandenberg AFB by a digitized communication system linking the MFCC with the CCT sites. In central control, only the Missile Flight Control Officer (MFCO) can initiate the radiation of the flight termination control functions. In the case of a complete failure of the digitized communication link, the site operator can assume control of the site and can initiate the tranmission of flight termination control functions when directed by the MFCO on voice direct communication.

Site-to-site switchover is conducted manually by the Command Transmitter Controller (CTC). By operational procedures, planned switchover does not result in a carrier off-the-air time greater than 55 ms or carrier overlap greater than 15 ms. A summary of site characteristics is shown in table 7-1.

A real-time recorder is provided in the MFCC at the Command Transmitter Controller Console (CTCC). All the events relative to operation and configuration of the system are recorded.

The system is designed so that no single point failure will cause the transmission of an undesired flight termination command control function or prevent the MFCO from initiating the transmission of a flight termination command control function.

The probability of mission accomplishment over a 4-hour operating period (launch countdown and missile flight) is greater than 0.999. The probability of transmitting an undesired command within a 1-hour operating period (launch countdown and missile flight) is less than $1x10^{-5}$. Any data links between the MFCC and the sites will in themselves have a probability of less than $1x10^{-7}$ in misinterpreting an undesired command.

Table 7-1

COMMAND CONTROL TRANSMITTER SYSTEM SUMMARY

	SITE 1	SITE 3	SITE 4	SITE 6A
SITE CODE	038301	028302	218301	008302
SITE LOCATION	North VAFB	South VAFB	Pillar Point AFS	NAS Point Mugu
GEODETIC COORDINATES (WGS 72)	34°46'12.2" N 120°30'22.8" W	34°35'27.1" N 120°36'43.9" W	37°29'48.8" N 122°29'55.9" W	34°6'26.9" N 119°3'57.1" W
ELEVATION	890 ft m.s.l.	1225 ft m.s.l.	177 ft m.s.l.	1402 ft m.s.l.
POWER	10 kW	10 kW	10 kW	10 kW
OMNI ANTENNA	Andrew Model 63608	Andrew Model 63608		
OMNI ANTENNA GAIN	2.0 dBi	2.0 dBi		
DIRECTIONAL ANTENNA	Datron Steerable Parabolic	Datron Steerable Parabolic	Datron Steerable Parabolic	Datron Steerable Parabolic
DIRECTIONAL ANTENNA GAIN	23.0 dBi	23.0 dBi	23.0 dBi	23.0 dBi
DIRECTIONAL ANTENNA BEAMWIDTH	10° @ -3 dB	10° @ -3 dB	10° @ -3 dB	10° @ -3 dB

AUTHORIZED OPERATING FREQUENCIES: 416.5 MHz Primary
406.5 MHz Secondary

NOTE: 1. *SAMTEC Geodetic Coordinates Manual, Part 1, February 1978.*
2. *The CCT antennas radiate LHCP waves whose sense is left handed according to the IEEE definition of sense. (Reference: IEEE Test Procedure for Antennas, Number 149, January 1965, p. 7.)*
3. *Coordinates for CCT Site 6B (008303) are as follows: 34°6'27.11" N; 119°3'57.0" W. Elevation 1424 ft m.s.l. All other data identical to CCT Site 6A.*

7.1 CCT Sites 1, 3, 4 and 6 Descriptions (See table 7-1)

The CCT sites can be operated in central control from the MFCC or in site control. Local site control cannot be taken unless remote central control has been released.

A total of nine command functions can be ordered by switch closure in either the central or site control mode. Two automatic command functions can be ordered by the range safety real-time computer. Various scenarios can be preprogrammed into site logic for automatic time-based sequencing and/or multiple function transmissions.

Primary-to-secondary transmitter switchover occurs whenever a specific preset incident or reflected power condition occurs. Carrier off-the-air fail-over time is less than 55 ms.

Station location and coverage is described in paragraph 7.0. Reliability is specified at the system level only and is also described in paragraph 7.0.

The CCT sites have only electrical/electronic control interfaces with the MFCC. Site 6 is configured as two individual transmitters with separate power sources (diesel generators) and antenna systems.

7.1.1 Encoder

7.1.1.1	Description -	FEC Model SK11482-AG1 audio frequency coder at sites 1 and 3; Rockland 51 systems tone generator at sites 4 and 6.
7.1.1.2	Available Tones	1 through 6 @ sites 1 and 3, 1 Hz to 3 MHz @ sites 4 and 6
7.1.1.3	Number of Simultaneous Tones	2
7.1.1.4	Tone Frequency Tolerance	±2 Hz
7.1.1.5	Distortion	<0.2%
7.1.1.6	Composite Signal Amplitude Stability	±10%
7.1.1.7	Tone Off Level	0
7.1.1.8	Order Repetition Rates	10 kHz
7.1.1.9	Turn On Delay Time (to 90-Percent Level)	15 ms @ sites 1 and 3, 2μs @ sites 4 and 6
7.1.1.10	Turn On Jitter at Maximum Repetition Rate	10μs
7.1.1.11	Turn Off Delay Time	2μs
7.1.1.12	Composite Transient Output (Switching)	None
7.1.1.13	Command Function Tone Balance	1 dB

7.1.2 RF Source

7.1.2.1	Description -	HP 8660A at sites 1 and 3 fed into Aydin 1650A1 amp; 3 DBM Inc. Model 504-429/10W-36 GP at sites 4 and 6.
7.1.2.2	Frequency Range	406.5-428.5 MHz
7.1.2.3	Assigned Operating Frequency	416.5/406.5 MHz

7.1.2.4 Frequency Tolerance (Accuracy and Stability)	±0.00004%
7.1.2.5 Deviation Linearity	<10%
7.1.2.6 Maximum Modulated Deviation	120 kHz peak
7.1.2.7 Maximum Residual Modulation	-135 dBc
7.1.2.8 Maximum Driver Output	10 W

7.1.3 RF Final

7.1.3.1 Description - Aydin Model 1206A, Spec DS-25791-ROIT-00041	
7.1.3.2 Power Output	10 kW
7.1.3.3 Harmonic and Spurious Outputs	-35 dBc, -75 dBc
7.1.3.4 Bandwidth	3 MHz
7.1.3.5 RF Leakage in Standby Mode	<100 dBc

7.1.4 Antennas

7.1.4.1 Fixed

7.1.4.1.1 Description - Andrews 63608	
7.1.4.1.2 Polarization	Left circular
7.1.4.1.3 Gain	2 dBi
7.1.4.1.4 Beamwidth	Omni
7.1.4.1.5 Power Rating	15 kW
7.1.4.1.6 Impedance	500Ω
7.1.4.1.7 Frequency Range	400-427 MHz
7.1.4.1.8 Voltage Standing Wave Ratio (VSWR)	1.5:1

7.1.4.2 Steerable

7.1.4.2.1 Description - Tec West Directional PF-15-12 at sites 1, 3 and 4; Andrews Model 60015-40 at site 6

7.1.4.2.2 Polarization	Left circular
7.1.4.2.3 Gain	23 dBi
7.1.4.2.4 Beamwidth	10° @ 3 dB
7.1.4.2.5 Sidelobes	-12 dB
7.1.4.2.6 Power Rating	15 kW
7.1.4.2.7 Type Feed	Helix
7.1.4.2.8 Impedance	50Ω
7.1.4.2.9 Frequency Range	400-427 MHz
7.1.4.2.10 VSWR	1.5:1 max
7.1.4.2.11 Type Mount, Mfr, Model	Canoga 8417 pedestal
7.1.4.2.12 Maximum Slew Rates, Azimuth and Elevation	12°/s
7.1.4.2.13 Positioning Lag	2°
7.1.4.2.14 Pointing Accuracy	0.1°

7.1.5 Monitor Receiver

7.1.5.1 Description - York Model D-1062 at sites 1 and 3,
FEC Model SK12901-AG-1 at sites 4 and 6.

7.1.5.2 Frequency Range	406.5-427.5 MHz
7.1.5.3 Tuning Method	Crystal
7.1.5.4 Modulated Band Pass (3 dB)	±0.5 MHz
7.1.5.5 Antenna Type and Characteristics	Omni
7.1.5.6 RF Sensitivity	-10 dBm
7.1.5.7 Audio Output Level	1.7 V @ 120 kHz
7.1.5.8 Audio Output Bandwidth	150 kHz

7.1.6 Decoder

7.1.6.1 Description - Part of monitor receivers	
7.1.6.2 Number of Channels	Programmable
7.1.6.3 Channel Bandwidth	Programmable
7.1.6.4 Deviation/Input Range	20-150 kHz
7.1.6.5 Command Output Response Time	<2.5 ms

7.1.7 Recording System

7.1.7.1 Description - G&S Systems Model GS-SD-05, two-channel synchro-to-digital antenna position printers; FEC Model SK12924, magnetic tape recorders/printer data system.

The two-channel synchro-to-digital antenna position printers which exist at each site provide the following data:

Azimuth angle
Elevation angle
Time of day
Missile liftoff indication

The magnetic tape recorder/printer data system at each site provides the following data:

Detailed system functioning
Performance
Status

7.1.7.2 The MFTCGS controller console, located in the Range Operations Building, is configured with stripchart recorders depicting the following events:

Standard operational mode	Carrier radiated
ICRS operational mode	Check channel ordered
CCT sites 1-6 ON/OFF	Check channel radiated
CCT sites 1 and 3 RF power	Optional command ordered
Computer enable and armed	Optional command radiated
ARM function ordered by computer	ARM (engine shutdown) ordered
Optional command ordered by computer	ARM (engine shutdown) radiated
IRIG timing trace	DESTRUCT ordered
Missile liftoff	DESTRUCT radiated

Chapter 8

EASTERN SPACE AND MISSILE CENTER (ESMC)
PATRICK AFB, FLORIDA

8.0 Eastern Space and Missile Center (ESMC) System

The ESMC command/control system consists of a network of six radio transmitting systems at the following sites: Cape Canaveral Air Force Station (CCAFS), Grand Bahama Island (GBI), Antigua, onboard the USNS *Redstone*, and NASA's Bermuda and Wallops Island stations (figure 8-1). The land-based sites are linked to the CCAFS Range Safety Officer (RSO) console located in the Range Control Center (RCC) for center point control operation. For northerly launch azimuths, the NASA Bermuda and Wallops Island stations are used by range safety when additional coverage is needed.

The command destruct system on the USNS *Redstone* provides the capability for mobile command transmitters. This system primarily supports the USN Fleet Ballistic Missile Programs in conjunction with the Launch Area Support Ship (LASS) from which the request for flight termination is made. In addition, there is a mobile van with a command destruct capability located at Ponce DeLeon Inlet, just south of Daytona Beach, Fla. This system is controlled from the RCC and is used primarily because of flame attenuation problems from the solid rocket boosters of the Space Shuttle. The ESMC command/control system is capable of coverage of easterly launch azimuths from launch to burnout, or orbital insertion of space vehicles.

The ESMC command/control system is used almost exclusively for range safety purposes. Any range-user functions such as the "safe" command will be sent upon user request, but functions such as missile control, etc., are not encouraged and will be approved only on a case-by-case basis.

The configuration for the command remoting system is shown in figure 8-2. The Central Command Message Encoder/Verifier (Central CME/V) accepts switch closures from the RSO console or from a console for the Command System Controller (CSC), which is the checkout console in the RCC. It outputs the corresponding message or messages from memory for serial data transfer to Site Command Message Encoder/Verifiers (Site CME/Vs) located at the command transmitting sites. Similarly, responses from the command transmitting sites and status information is remoted from the Site CME/V to the Central CME/V for display to the RSO and/or the CSC. The CSC console provides for programming the command system for use as required by the RSO mission needs. The Site CME/V interfaces with the Digital Command Terminals (DCT) for generation of range safety commands and with the transmitting subsystem.

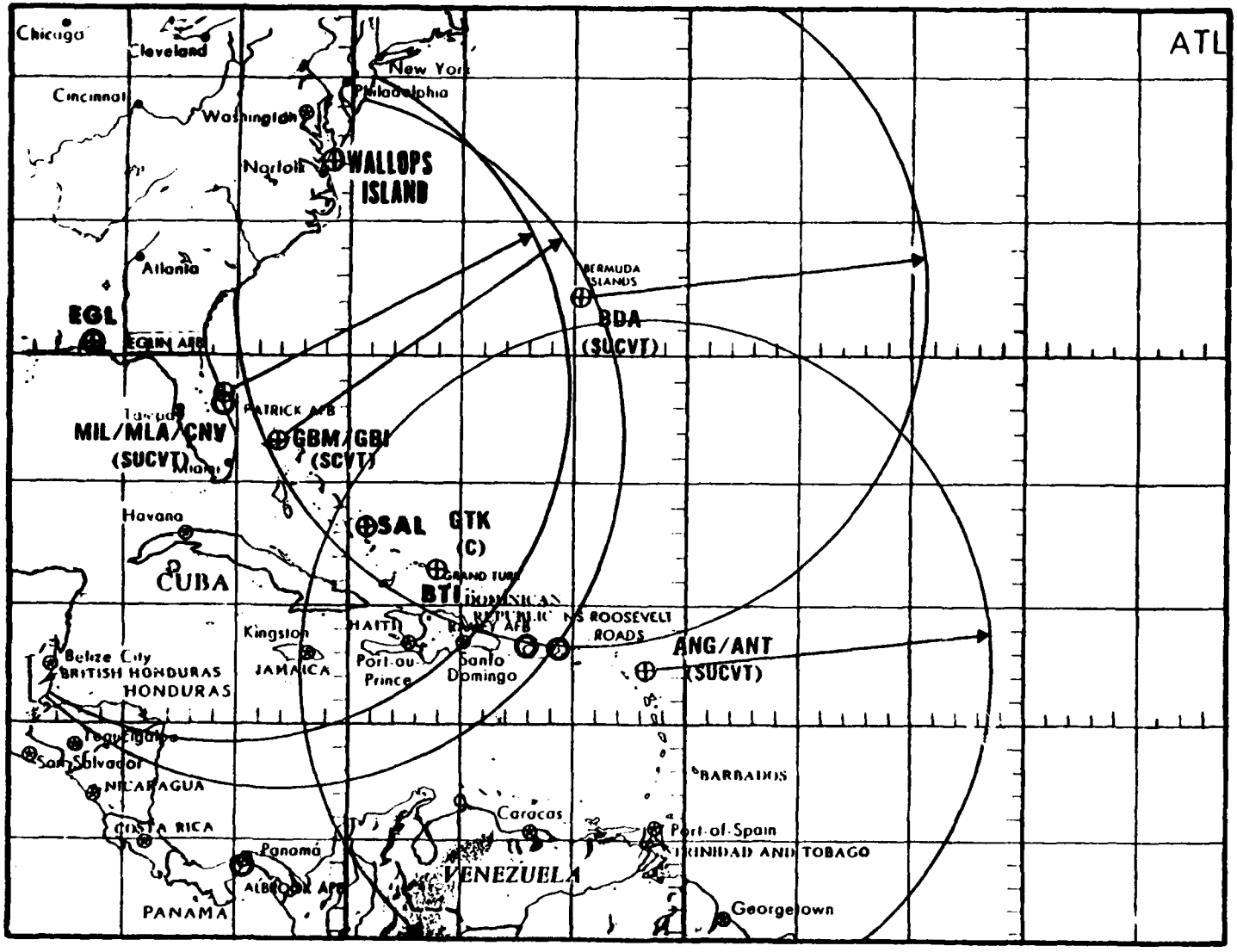


Figure 8-1 CCS System Area Coverage at ESMC.

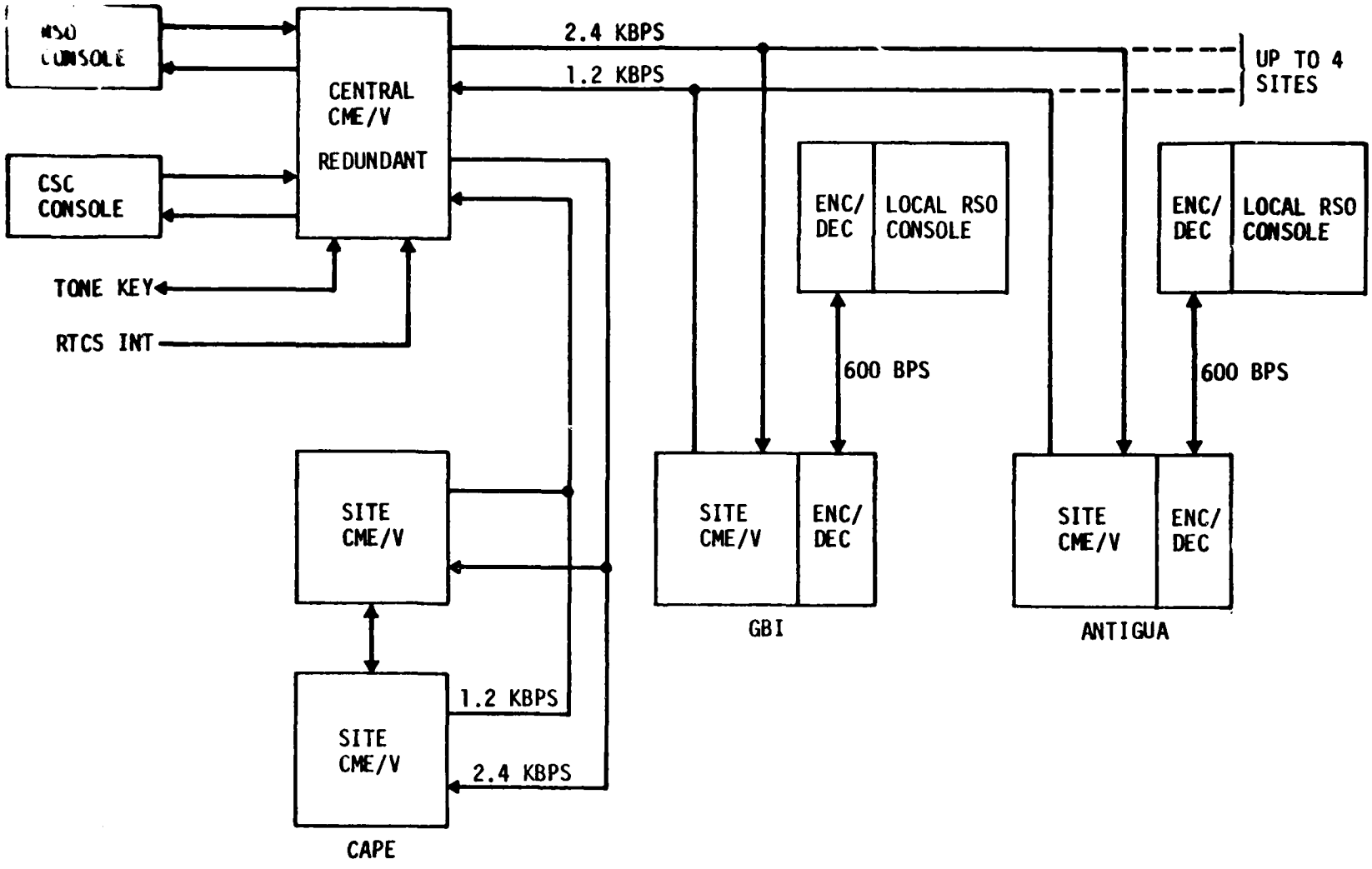


Figure 8-2 Command Remoting System Configuration.

Operational redundancy in remotely controlling a downrange site is provided, that is, the local RSO console at a downrange station can provide control of the local command system. Encoder/decoder links are available for this purpose. These links can be inhibited unless a failure should occur in the subcable channel or Site CME/V.

The communication between the Central CME/V and the Site CME/Vs is via 2.4 kb/s modems. The status data from the Site CME/Vs to the Central CME/V use multiplexed features of the modems with a selectable data rate of either 600 b/s or 1200 b/s from each Site CME/V. The encoder/decoders contain modulators and detectors necessary for operation at 600 b/s over land-line circuits.

The functional capability of the remoting system is as follows:

Central to Site CME/V Traffic

Command Requests	16
System Control Functions	16
Tone Key Requests	20, 6 simultaneously

Site to Central CME/V Traffic (Per Site)

Command Confirmation	16
System Control Confirmation	16
Tone Key Confirmation	20
Command System Status	32
Other System Status	32

This provides a system which can be programmed to accommodate various operational scenarios with a minimum of hardware changes. For example, a command request activation which must be precisely controlled in time could involve the transmission of a "time-to-activate instruction" to a Site CME/V.

A command request (ARM, DESTRUCT, etc.) effected by the Cape RSO or during checkout from the CSC console causes the appropriate message to be transmitted to the Site CME/V which then activates the corresponding request to the DCT. The transmitted message contains both a primary and verify word which separately activates the primary and verify command request lines of the DCT. Since redundant memory within the DCT is thusly operated, fail-safe command generation is effected from the Central CME/V.

A message containing a particular instruction from Central is repeated three times after which the next ordered priority instruction can be handled. Upon receipt of two of the three messages at the Site

CME/V, the instruction is acted upon and a verification message is transmitted to Central. If this verification is not received within an allowable time, the message is repeated three times. The Site acceptance of a critical instruction (command request, carrier request, etc.) is based upon receipt of two out of three messages. The acceptance rate of messages is maximized by the use of error detection/correction techniques.

The command system status information is periodically remoted to Central. Also any change in the status of a critical confirmation such as command or carrier confirm is transmitted on an interrupt basis.

Carrier handover from one site to another is controlled by the Central CME/V based upon time-after-first-motion, elevation angle of missile to each site and, perhaps, telemetered received signal strength (or slant range). The RSO has override control of the various carriers from the console.

Since the carriers are under firmware control, various modes are employed such as the following:

Mode 1 - To assure continuous capture of a single vehicle, CARRIER OFF instructions are not transmitted to other sites after a different site has been ordered ON until confirmation that its carrier is radiating.

Mode 2 - To provide rapid switching of carriers (might be required for multiple in-flight vehicles), the Central CME/V can control carriers by transmitting the CARRIER ON message (or command request message) to the desired site and a CARRIER OFF message to that site which is known by the latest status report to be ON.

Since the Central CME/V has the capability of making decisions based upon information from the Central Computer Complex and stored criteria for the selection of sites, an automatic operational mode can be employed. A command request is addressed to the selected site upon a console activation. The addressed command request effects automatic turn ON of that site (if not already on) using Carrier Control Mode 2. The Central CME/V simultaneously initiates a CARRIER OFF instruction to any other site known by the periodic status-reporting feature to have its CARRIER ON. Alternately, all sites could interpret a command request addressed to a differ nt site as a CARRIER OFF instruction.

The command/control antenna system is as follows:

CCAFS - 2 Canoga (steerable)
1 Melpar high-power omni
1 Gabriel low-power omni

GBI - 2 ESCO (steerable)

Antigua - 1 ESCO (steerable)
1 TEMEC dish (steerable)

USNS *Redstone* - 2 high-power helicon (fixed)

Bermuda - 2 Canoga (steerable)

Wallops Island - 2 Canoga (steerable)

Van - 1 Helix high-power (fixed)

Command designate units are used to slave the steerable antennas to the EFG (Earth Centered Coordinate System) designate circuits. The command designate unit receives the Range Standard 2400 b/s EFG data from the Central Computer Complex and provides elevation and azimuth synchro signals for pointing one or two antennas at a single object. It also accepts EFG data containing two frames per second for four objects. A control/status interface is included to permit real-time assignment of a target to each antenna via the site remoting terminal. Selection can also be made by the operator. In addition, an interface is provided to externally control the antennas by digital data input upon malfunction of the normal designate operation.

A monitoring subsystem is used primarily to provide a record of each ESMC command system performance. This capability also provides a real-time monitor of system performance and display to the operator. There is one monitoring terminal at each command site. The data resulting from system monitoring is logged onto the IBM compatible digital magnetic tape. The monitoring of interfaces and logging onto magnetic tape is controlled by a microcomputer. The capability of the monitoring and recording subsystem is listed below:

Range Timing

Synchro Data

Antenna 1 Azimuth
Antenna 1 Elevation
Antenna 2 Azimuth
Antenna 2 Elevation

Analog Data

Antenna 1 Radiated Power Level
Antenna 2 Radiated Power Level
Transmitter Incident Power Level
Transmitter Reflected Power Level

Events/Status

Ready
CARRIER ON
W1 Confirm (DESTRUCT Transmitted)
W2 Confirm (ARM Transmitted)
W3 Confirm (SAFE Transmitted)
W4 Confirm
X1 Confirm
X2 Confirm
X3 Confirm
X4 Confirm
Y1 Confirm
Y2 Confirm
Y3 Confirm
Y4 Confirm
8 IRIG Digital Command Terminal Tones
Antenna 1 or 2 Selected
DRS Test/Operate

All downrange sites, including NASA Bermuda and Wallops Island, are essentially the same as those which pertain to the command remoting system. There are only minor differences in antennas and RF exciters used at the different sites. In addition to the normal command destruct system, each site is equipped with redundant digital range safety equipment which interfaces the normal system with the site transmitting subsystem for use with the Space Transportation System.

Command Control Sites Summary:

(1) Station 1, Cape Canaveral AFS, Fla., is located at 28°26'21.3" x 80°35'54.6"; elevation - sea level; power output operating levels - 600 W and 8 kW.

(2) Station 3, Grand Bahama Island, is located at 26°37'4.4" x 78°21'36.9"; elevation - sea level; power output operating level - 8 kW.

(3) Station 91, Antigua, is located at 17°8'11.4" x 61°46'29.6"; elevation - sea level; power output operating level - 8 kW.

(4) Station 67, NASA Bermuda, is located at 32°20'52.8" x 64°39'12.6"; elevation - sea level; power output operating level - 8 kW.

(5) Station 86, NASA Wallops Island, Va., is located at 37°51'59.3" x 75°30'17.9"; elevation - sea level; power output operating level - 600 W.

8.1 Command Control Transmitter Sites Descriptions

All CCT sites can be operated from the RSO console in the RCC. Although local site control at the downrange sites is inhibited during normal launch operations, local control can be restored in the event of loss of control links from the RCC. Transmitter switchover to downrange stations is automatically preprogrammed according to expected missile trajectory. In the case of a malfunctioning launch vehicle, the programmed switchover can be interrupted and a transmitter site selected manually by the RSO.

8.1.1 Encoder

8.1.1.1	Description - ARF Products Model ASG-8, land sites, KY-171, Bermuda.	
8.1.1.2	Available Tones	20
8.1.1.3	Number of Simultaneous Tones	6
8.1.1.4	Tone Frequency Tolerance	±0.1%
8.1.1.5	Distortion	1% max
8.1.1.6	Composite Signal Amplitude Stability	±5% max
8.1.1.7	Turn On Delay Time (to 90-Percent Level)	0.5 ms
8.1.1.8	Turn On Jitter at Maximum Repetition Rate	±50μs
8.1.1.9	Turn Off Delay Time	0.5 ms

8.1.2 RF Source

8.1.2.1	Description - Reaction Instruments, Inc., Model 6031 at Cape and Bermuda sites; Collins 52Q1-TH at GBI and Antigua.	
8.1.2.2	Frequency Range	406-450 MHz
8.1.2.3	Assigned Operating Frequency	416.5 MHz
8.1.2.4	Frequency Tolerance (Accuracy and Stability)	±0.005%
8.1.2.5	Deviation Linearity	5%
8.1.2.6	Maximum Modulated Deviation	±300 kHz peak

8.1.2.7 Maximum Residual Modulation	3 kHz peak
8.1.2.8 Maximum Total Distortion (at Maximum Deviation)	5% max
8.1.3 RF Final	
8.1.3.1 Description - Collins 240 D-2 at all ESMC sites, MCL Model 10270 also used at Cape land sites.	
8.1.3.2 Power Output	10 kW max
8.1.3.3 Harmonic and Spurious Outputs	<-60 dB
8.1.3.4 Bandwidth	3 MHz
8.1.4 Antennas	
8.1.4.1 Fixed	
8.1.4.1.1 Description - See paragraph 8.0.	
8.1.4.1.2 Polarization	Left circular
8.1.4.1.3 Gain	6-10 dB
8.1.4.1.4 Beamwidth	15°-45°
8.1.4.1.5 Type Feed	Coaxial
8.1.4.1.6 Impedance	50Ω
8.1.4.1.7 Frequency Range	406-450 MHz
8.1.4.1.8 Voltage Standing Wave Ratio (VSWR)	<1.5:1
8.1.4.2 Steerable	
8.1.4.2.1 Description - See paragraph 8.0.	
8.1.4.2.2 Polarization	Left circular
8.1.4.2.3 Gain	15-23 dB
8.1.4.2.4 Beamwidth	8°-20°
8.1.4.2.5 Power Rating	10 kW

8.1.4.2.6 Type Feed	Coaxial
8.1.4.2.7 Impedance	50Ω
8.1.4.2.8 Frequency Range	406-450 MHz
8.1.4.2.9 VSWR	<1.5:1
8.1.4.2.10 Maximum Slew Rates, Azimuth and Elevation	25° AZ 12° EL

8.1.5 Monitor Receiver

8.1.5.1 Description - Collins R-669	
8.1.5.2. Frequency Range	406-450 MHz
8.1.5.3 Tuning Method	Step incremental
8.1.5.4 Modulated Band Pass (3 dB)	±1 MHz
8.1.5.5 Antenna Type and Characteristics	RF probe
8.1.5.6 RF Sensitivity	10 kμV
8.1.5.7 Audio Output Level	5 V p-p max
8.1.5.8 Audio Output Bandwidth	5-75 kHz

8.1.6 Decoder

8.1.6.1 Description - KY-172 at Bermuda, AFF-15 at other sites.	
8.1.6.2 Number of Channels	20
8.1.6.3 Receiver Coupled Threshold Sensitivity	0.25 V rms
8.1.6.4 Channel Bandwidth	±2.5%
8.1.6.5 Deviation/Input Range	30-300 kHz
8.1.6.6 Adjacent Channel Rejection	>40 dB
8.1.6.7 Command Output Response Time	2.0 ms max
8.1.6.8 Response Jitter	±0.1 ms

8.1.7 Recording System

8.1.7.1 Description - Wango Model 11 magnetic tape unit with a DEC LSI-11 controller

8.1.7.2 Functions Recorded:

Tones ordered remotely
Tones transmitted
Transmitter radiating
Active antenna
Power level
Antenna position
Transmitter fault

Chapter 9

NASA WALLOPS FLIGHT CENTER (WFC)
WALLOPS ISLAND, VIRGINIA

9.0 Wallops Flight Center (WFC) System

The command/destruct system at Wallops Station (figure 9-1) provides ground control of certain rocket and payload functions for flight safety and/or command purposes. The range user can employ these systems to command payload functions as necessary, within range limitations. Each system consists of two Aleph transmitters with Antlab quad-helix antennas. The RF carrier is frequency modulated by certain preselected tones that correspond to particular functions that are to be performed on the rocket or payload. The transmitter signals are monitored at the transmitter by a self-contained RF monitor and audio decoder combination at the frequency monitoring and interference control site and at the receiver site.

The command/destruct antenna subsystem used at the Transmitter Building and the antenna used with the mobile command/destruct system are identical quad-helix arrays mounted on elevation-over-azimuth pedestals. The antennas can be pointed by local or remote control by using synchro information received from a remote source such as radar. The antennas are designed for continuous rotation in azimuth and 190° in elevation. They are left hand circular polarized with an 18-dB gain and a 20° beamwidth.

The mainland site is located at 37.8665° latitude, 75.5050° longitude (figure 9-2), with an elevation of 48.0325 ft m.s.l.

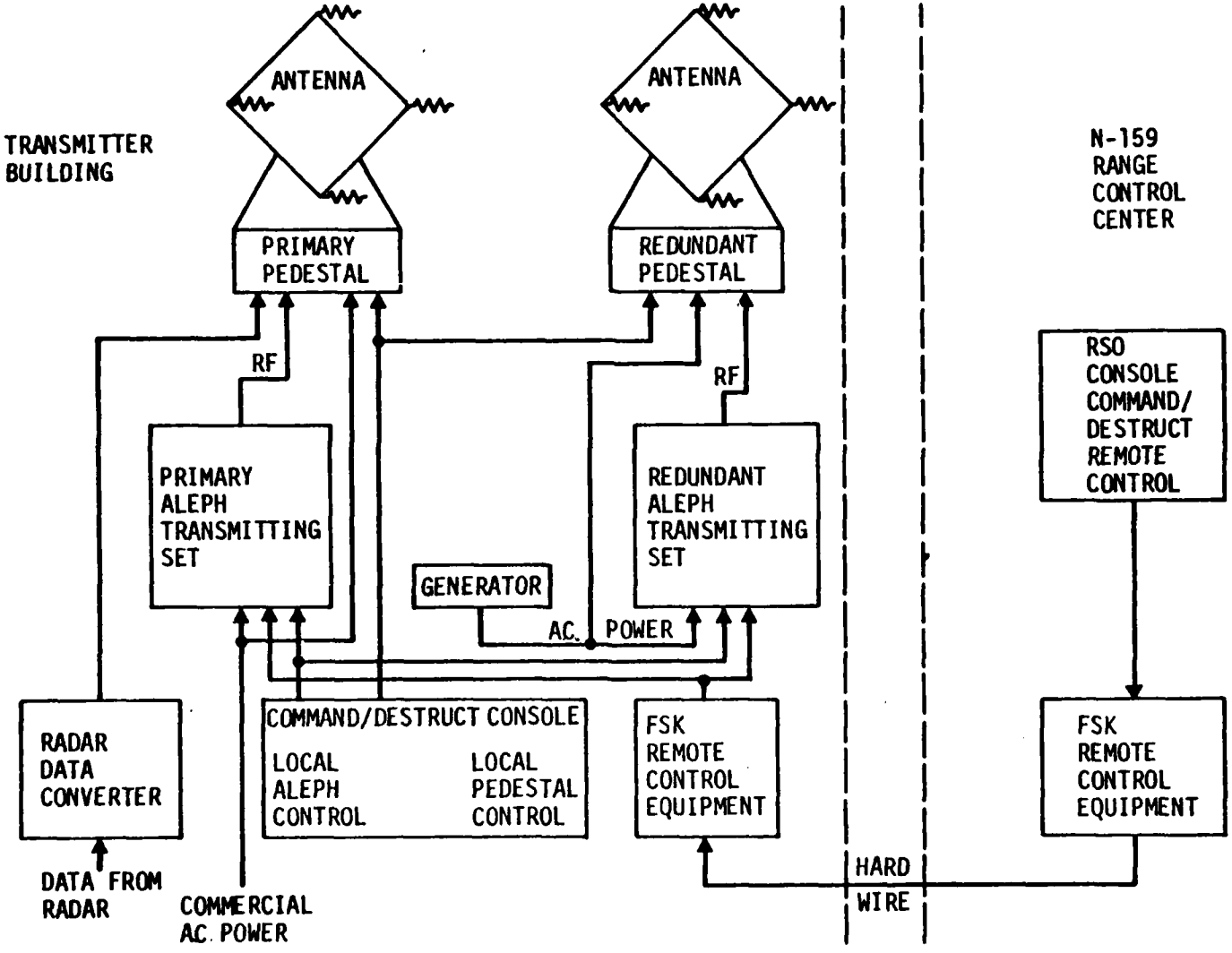


Figure 9-1 Block Diagram of Command/Destruct System at Wallops Station.

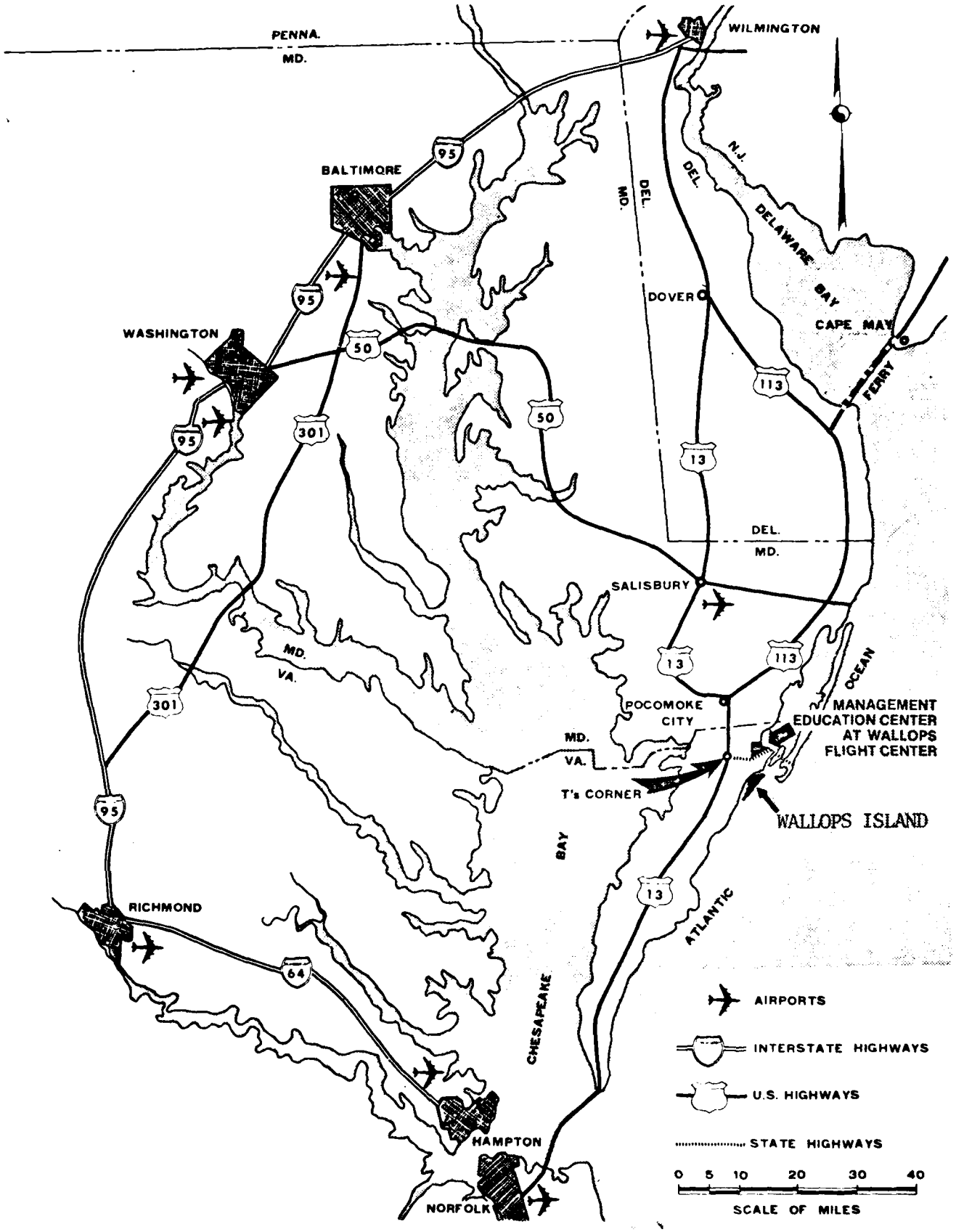


Figure 9-2 Wallops Flight Center.

9.1 Mainland System

The Wallops mainland command/destruct system is located at the Transmitter Building, U-55, on Wallops mainland. This system consists of two subsystems connected in a fail-over arrangement. If the primary subsystem fails, or if the RF power output falls below a predetermined level, the B+ power is applied to the redundant subsystem. The redundant subsystem then assumes control of the command/destruct functions. Transmitter modulation can be controlled locally or by remote control from the Range Control Center in Building N-159 by Frequency Shift Keying (FSK). The transmitter and antenna pedestal operate from commercial a.c. power with backup generator power supplied to the redundant transmitter. The primary antenna is slaved by means of the Milgo data acquisition bus to the radar providing the most accurate position information on the rocket/payload being tracked. The redundant antenna is positioned remotely using predetermined angle versus time information. The Range Safety Officer (RSO), by the use of an FSK system, can remotely control certain functions of the rocket or payload such as the arming and destruction of a rocket, or specific rocket or payload mission commands that may be required.

The mobile command/destruct system consists of two AN/FRW-2A radio transmitting sets and associated equipment mounted in a mobile unit. The equipment is connected in a fail-over arrangement and can be used downrange for prime operation or as a backup system in support of the Wallops mainland system. The transmitters share one antenna identical to the mainland units which is coaxially switched to the active transmitter. A small, manually pointed, crossed-dipole antenna is used as a spare. Transmitter modulation can be controlled locally or remotely from the Range Control Center, with hardwire interface, using an FSK system.

9.1.1 Encoder

9.1.1.1	Description - Aleph, Inc.	
9.1.1.2	Available Tones	20
9.1.1.3	Number of Simultaneous Tones	6
9.1.1.4	Tone Frequency Tolerance	0.03%
9.1.1.5	Distortion	1%
9.1.1.6	Composite Signal Amplitude Stability	10%
9.1.1.7	Tones Off Level	1% of normal output

AD-A080 471 RANGE COMMANDERS COUNCIL WHITE SANDS MISSILE RANGE NM--ETC F/G 17/2.1
RANGE SAFETY TRANSMITTING SYSTEMS, 406-549 MHZ BAND.(U)
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UNCLASSIFIED RSG-307-79 NL

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9.1.1.8 Turn On Delay Time (to 90-Percent Level)	<1 ms
9.1.1.9 Turn Off Delay Time	<1 ms
9.1.1.10 Command Function Tone Balance	10%
9.1.2 RF Source	
9.1.2.1 Description - Aleph, Inc.	
9.1.2.2 Frequency Range	406-549 MHz
9.1.2.3 Assigned Operating Frequency	412/416.5 MHz
9.1.2.4 Frequency Tolerance (Accuracy and Stability)	0.0005%
9.1.2.5 Deviation Linearity	0-300 kHz
9.1.2.6 Maximum Modulated Deviation	±300 kHz
9.1.2.7 Maximum Residual Modulation	±2 kHz
9.1.2.8 Maximum Total Distortion (at Maximum Deviation)	<2%
9.1.2.9 Maximum Driver Output	50 W
9.1.3 RF Final	
9.1.3.1 Description - Aleph, Inc.	
9.1.3.2 Power Output	1 kW
9.1.3.3 Harmonic and Spurious Output	70 dB below
9.1.3.4 Bandwidth	3 MHz nominal
9.1.3.5 RF Leakage in Standby Mode	Conforms to MIL-STD-461
9.1.4 Antennas	
9.1.4.1 Fixed	
9.1.4.1.1 Description - None available.	

9.1.4.2 Steerable	
9.1.4.2.1 Description - Antlab	
9.1.4.2.2 Polarization	Left circular
9.1.4.2.3 Gain	18 dB
9.1.4.2.4 Beamwidth	20°
9.1.4.2.5 Power Rating	10 kW
9.1.4.2.6 Type Feed	Coaxial-117
9.1.4.2.7 Impedance	50Ω
9.1.4.2.8 Frequency Range	400-550 MHz
9.1.4.2.9 Voltage Standing Wave Ratio (VSWR)	<1.1:1
9.1.4.2.10 Type Mount, Mfr, Model	Antlab
9.1.4.2.11 Maximum Slew Rates, Aximuth and Elevation	25°/s
9.1.4.2.12 Pointing Accuracy	0.25°
9.1.5 Monitor Receiver	
9.1.5.1 Description - Various command receivers	
9.1.5.2 Frequency Range	400-550 MHz
9.1.5.3 RF Sensitivity	3μV
9.1.6 Decoder	
9.1.6.1 Description	
9.1.6.2 Number of Channels	20
9.1.6.3 Receiver Coupled Threshold Sensitivity	-30 dBm
9.1.6.4 Deviation/Input Range	±10-300 kHz
9.1.6.5 Adjacent Channel Rejection	60 dB
9.1.6.6 Signal/Noise Margin	4.0 dB/3μV

9.1.7 Recording System

9.1.7.1 Description

9.1.7.2 Functions Recorded:

Tones ordered locally
Transmitter radiating
Tones ordered remotely
Power level
Tones transmitted
Transmitter fault
Voice communications
Switchover time

Chapter 10

WHITE SANDS MISSILE RANGE (WSMR)
WHITE SANDS MISSILE RANGE, NEW MEXICO

10.0 White Sands Missile Range (WSMR) System

WSMR has six command control transmitter systems, three of which are fixed stations located as shown in figure 10-1. The other three systems are in mobile vans and can be utilized throughout the range as required. The three fixed sites and two of the mobile vans are equipped with Aleph, Inc. Command Transmitter Systems (CTSs). The other mobile van is equipped with a Microdot transmitter system. All transmitter sites employ log spiral UHF antennas manufactured by Tecom Industries. All antennas are fixed and provide hemispherical omnidirectional coverage throughout the range extension areas and other off-range sites (McGregor, Utah Launch Complex, etc.).

During missile/target flight tests, the transmitter stations are controlled and monitored by a Missile Flight Test Safety Manager (MFTSM) from either of two control sites. These control sites are Building 300 at WSMR and King 1 at Holloman AFB. A Lynch communication system links the control site(s) with the transmitter stations (figure 10-2) for carrier and transmission of any required flight termination functions. This is a solid-state, frequency-shift, narrow-band communication system designed for transmission of digital data and telegraph information. In case of link problems or failure, the site operator can assume control and initiate transmission of flight termination control functions under the direction of the MFTSM. A block diagram of a typical system is shown in figure 10-3.

All transmitter stations are designed with an emergency a.c. power source, redundant transmitters and antennas, switching units, and associated equipment which minimize failures that will cause a mission to abort, transmit undesired flight termination commands or prevent the transmission of such signals. In addition, each station is equipped with a 20-channel communications receiver and recorder for monitoring purposes. There is also a receiver located at Salinas Peak that is capable of monitoring off-the-air tone transmissions from any of the on-range transmitter stations. These transmissions can then be remoted for evaluation to any of the control sites through a Lynch communication system.

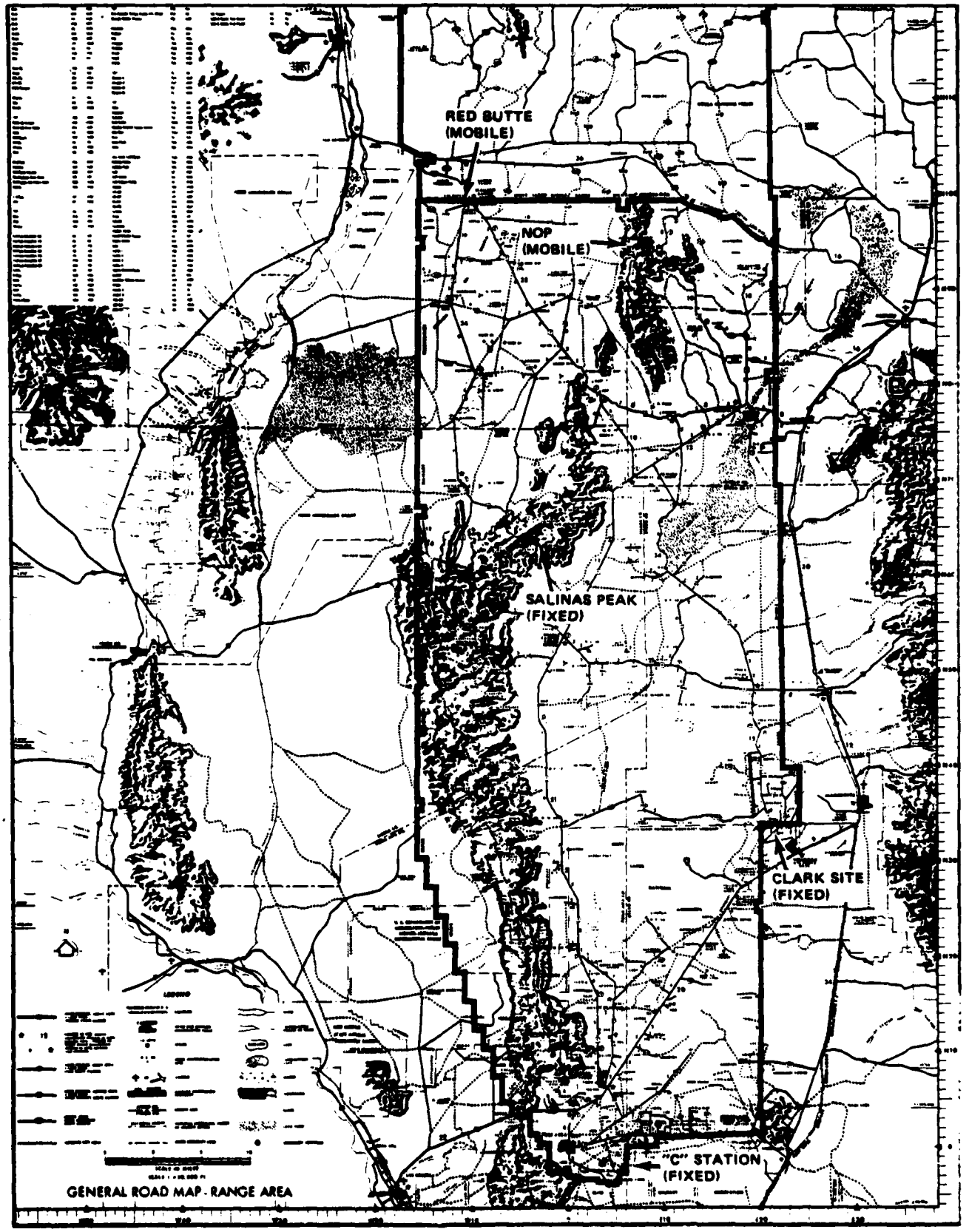

Figure 10-1 Command Control Transmitter Sites at WSMR.

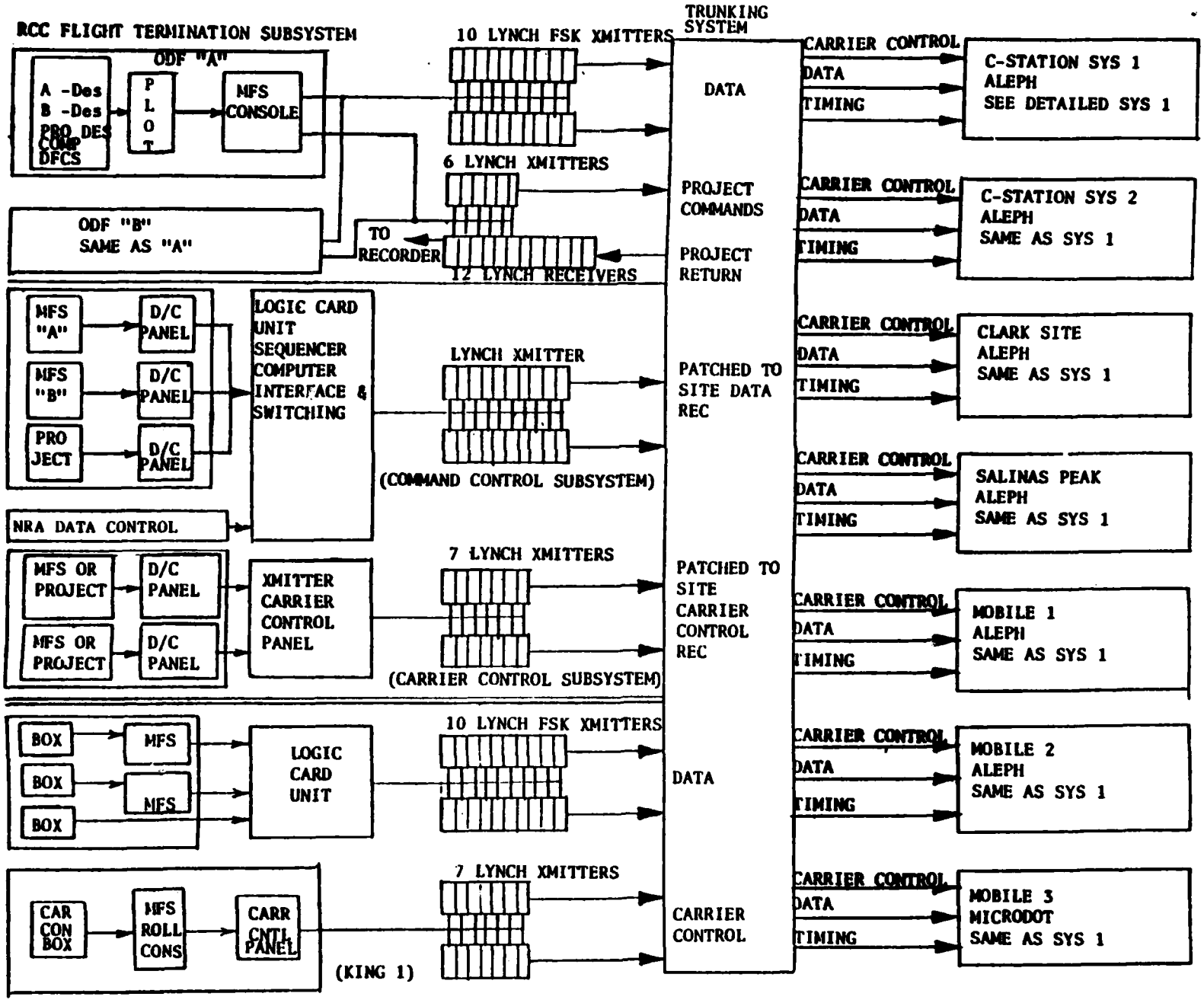

Figure 10-2 Remote Control System.

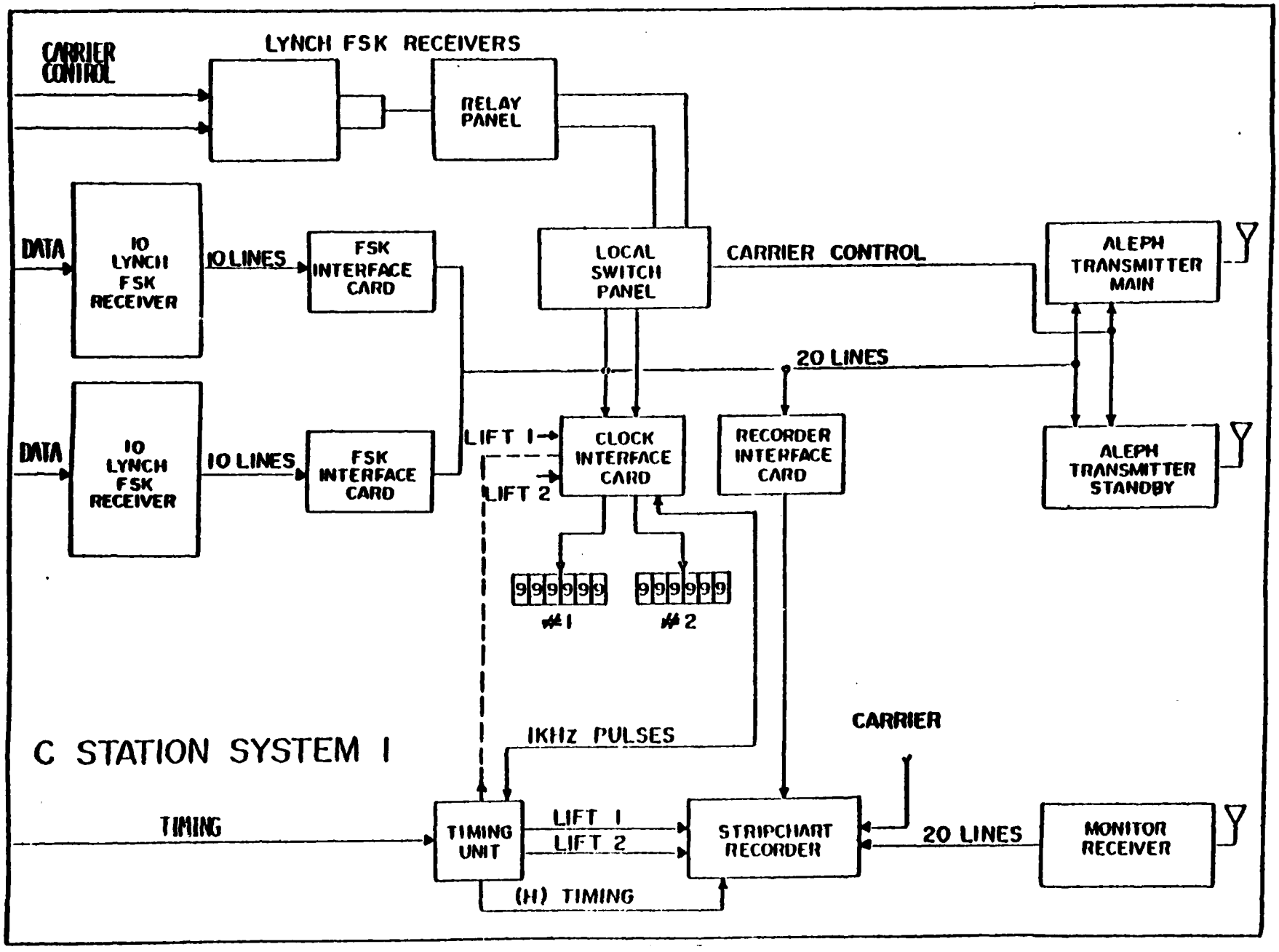

Figure 10-3 Block Diagram of a Fixed Site.

Site geodetics are as follows:

	LATITUDE	LONGITUDE	ELEVATION
Fixed Sites			
"C" Station	32°21'21"	106°22'30"	4015 ft m.s.l.
Clark Site	32°52'27"	106°07'01"	4094 ft m.s.l.
Salinas Peak	33°17'55"	106°31'51"	8958 ft m.s.l.
Mobile Sites			
North Oscura Peak (NOP)	33°45'10"	106°22'19"	7998 ft m.s.l.
Red Butte	33°49'33"	106°39'54"	5172 ft m.s.l.
Mobile Off-Range Sites			
Green River, UT	38°58'	110°06'	4340 ft m.s.l.
Blanding, UT	37°32'48"	109°28'32"	5775 ft m.s.l.
Fort Wingate, NM	35°23'40"	108°35'29"	6468 ft m.s.l.

10.1	Encoder	
10.1.1	Description - Microdot Model 2702 solid state	
10.1.2	Available Tones	20
10.1.3	Number of Simultaneous Tones	6
10.1.4	Tone Frequency Tolerance	0.01%
10.1.5	Distortion	1%
10.1.6	Composite Signal Amplitude Stability	±10%
10.1.7	Turn On Delay Time (to 90-Percent Level)	>1 ms
10.1.8	Turn Off Delay Time	>1 ms
10.1.9	Command Function Tone Balance	0-15 V
10.2	RF Source	
10.2.1	Description - Microdot Model 2435B	
10.2.2	Frequency Range	400-550 MHz
10.2.3	Assigned Operating Frequency	409 MHz
10.2.4	Frequency Tolerance (Accuracy and Stability)	±0.0005%, ±0.001%/h
10.2.5	Deviation Linearity	1%
10.2.6	Maximum Modulated Deviation	±300 kHz
10.2.7	Maximum Total Distortion (at Maximum Deviation)	2%
10.2.8	Maximum Driver Output	100 W
10.3	RF Final	
10.3.1	Description - Microdot	
10.3.2	Power Output	1 kW

10.4 Antennas

10.4.1 Fixed

10.4.1.1	Description - Tecom, Industries log spiral	
10.4.1.2	Polarization	Left circular
10.4.1.3	Gain	0 dB avg/hemis
10.4.1.4	Beamwidth	Hemispherical
10.4.1.5	Power Rating	1 kW
10.4.1.6	Type Feed	N-female
10.4.1.7	Impedance	50Ω
10.4.1.8	Frequency Range	406-550 MHz
10.4.1.9	Voltage Standing Wave Ratio (VSWR)	1.75:1

10.5 Monitor Receiver

10.5.1	Description - WSMR-fabricated monitor carrier and first 13 IRIG tones	
10.5.2	Frequency Range	409 MHz
10.5.3	Tuning Method	Fixed
10.5.4	Modulated Band Pass (3 dB)	200 kHz
10.5.5	Antenna Type and Characteristics	Dipole
10.5.6	RF Sensitivity	1μV

10.6 Decoder

10.6.1	Description - WSMR fabricated	
10.6.2	Number of Channels	13
10.6.3	Receiver Coupled Threshold Sensitivity	-30 dBm
10.6.4	Deviation/Input Range	10-300 kHz

10.6.5 Adjacent Channel Rejection 60 dB

10.6.6 Signal/Noise Margin 4.0 dB @ 3μV

10.7 Recording System

10.7.1 Description - Angus Easterling 40-channel recorder

10.7.2 Functions Recorded:

Tones ordered locally
Tones ordered remotely
Tones transmitted
Carrier control
Liftoff
Timing
Switchover time

10.8 Aleph Systems

The Aleph transmitter systems are comprised of two separate transmitter units. Each unit contains five modular subassemblies mounted in a standard transmitter rack. These five subassemblies are the final amplifier, solid-state unit, encoder, control panel and high voltage power supply. Each system also contains a switching unit which is the antenna-to-dual CTS interface. It contains a coaxial relay and solid-state control circuitry to regulate two CTS units and automatically direct the RF output of the active transmitter to the antenna port. The solid-state unit contains a frequency synthesizer and is capable of providing a 50-W signal output. The final amplifier uses a tunable cavity/triode amplifier to increase the 50-W signal to the ultimate 1-kW output. Antennas and system configurations are shown in figures 10-4 and 10-5.

Figure 10-4 Antenna System (Tecom Industries, Inc.).

Figure 10-5 Command/Control System (Aleph, Inc.).

10.8.1	Encoder	
10.8.1.1	Description - Aleph, Inc.	
10.8.1.2	Available Tones	20
10.8.1.3	Number of Simultaneous Tones	6
10.8.1.4	Tone Frequency Tolerance	0.03%
10.8.1.5	Distortion	1%
10.8.1.6	Composite Signal Amplitude Stability	10%
10.8.1.7	Tone Off Level	1% of normal output
10.8.1.8	Turn On Delay Time (to 90-Percent Level)	>1 ms
10.8.1.9	Turn Off Delay Time	>1 ms
10.8.1.10	Command Function Tone Balance	10%
10.8.2	RF Source	
10.8.2.1	Description - Aleph, Inc.	
10.8.2.2	Frequency Range	406-549 MHz
10.8.2.3	Assigned Operating Frequency	409 MHz
10.8.2.4	Frequency Tolerance (Accuracy and Stability)	0.0005%
10.8.2.5	Deviation Linearity	0-300 kHz
10.8.2.6	Maximum Modulated Deviation	±300 kHz
10.8.2.7	Maximum Residual Modulation	±2 kHz rms
10.8.2.8	Maximum Total Distortion (at Maximum Deviation)	1%
10.8.2.9	Maximum Driver Output	100 W max 50 normal
10.8.3	RF Final	
10.8.3.1	Description - Aleph, Inc.	

10.8.3.2	Power Output	1 kW
10.8.3.3	Harmonic and Spurious Output	70 dB below
10.8.3.4	Bandwidth	3 MHz nominal
10.8.3.5	RF Leakage in Standby Mode	

10.8.4 Antennas

10.8.4.1 Fixed

10.8.4.1.1 Description - The antennas are hemispherical log spiral manufactured by Tecom Industrices, Inc.

10.8.4.1.2	Polarization	Left circular
10.8.4.1.3	Gain	0 dB avg/hemis
10.8.4.1.4	Beamwidth	Hemispherical
10.8.4.1.5	Power Rating	1 kW
10.8.4.1.6	Type Feed	N-female
10.8.4.1.7	Impedance	50Ω
10.8.4.1.8	Frequency Range	400-550 MHz
10.8.4.1.9	VSWR	1.75:1

10.8.5 Monitor Receiver

10.8.5.1 Description - All transmitter stations are equipped with monitoring receivers. There are also monitoring receivers at Building 300 and King 1 control sites. Salinas Peak is equipped with a Communitronic LTD Model 12-D, wideband, solid-state UHF receiver tunable within the 400-550 MHz band. This receiver is capable of remoting the transmitted IRIG tones to either Building 300 and/or King 1.

10.8.5.2	Frequency Range	400-550 MHz
10.8.5.3	Tuning Method	Thumbwheel

10.8.5.4	Modulated Band Pass (3 dB)	200 kHz
10.8.5.5	Antenna Type and Characteristics	Dipole
10.8.5.6	RF Sensitivity	3μV

10.8.6 Decoder - Part of Communitronics receiver

10.8.6.1	Description - See subparagraph 10.2.5.	
10.8.6.2	Number of Channels	20
10.8.6.3	Receiver Coupled Threshold Sensitivity	-30 dBm
10.8.6.4	Deviation/Input Range	±10-300 kHz
10.8.6.5	Adjacent Channel Rejection	60 dB
10.8.6.6	Signal/Noise Margin	4.0 dB/3μV

10.8.7 Recording System

10.8.7.1 Description - Angus Easterling 40-channel inkless stylus recorder

10.8.7.2 Functions Recorded:

Tones ordered locally
Tones ordered remotely
Tones transmitted
Switchover time - 100ms
Carrier control
Liftoff
Timing